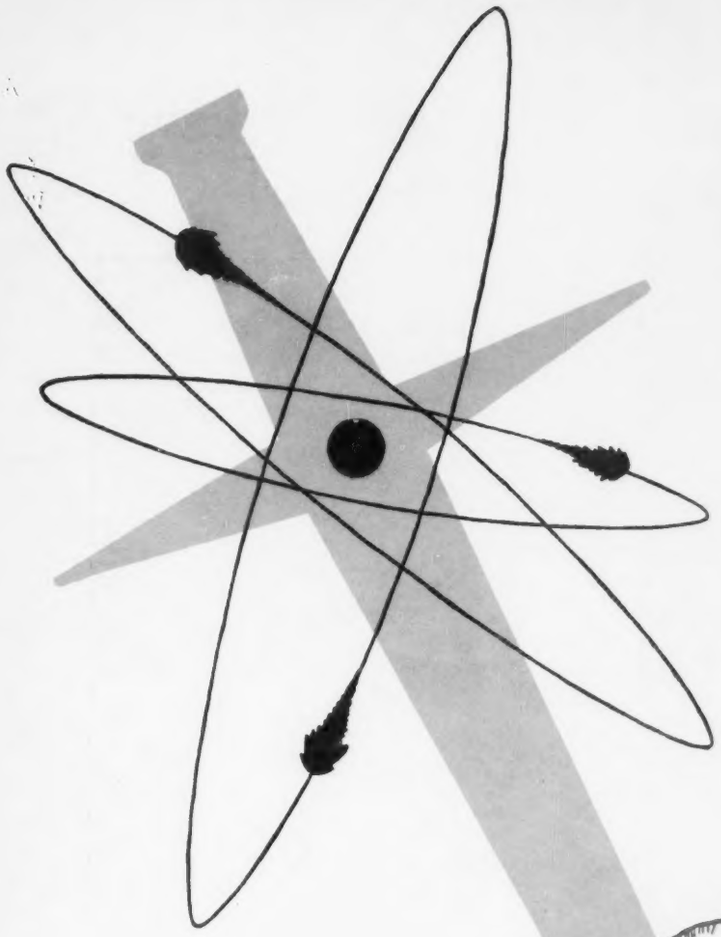
tech engineering news



may 1955

James Chisholm, class of '41,
speaks from experience when he says,

"Men with ability and ambition really have a chance to get ahead at U.S. Steel"

● A responsible position can come quickly to those graduate engineers at U.S. Steel who show ability and ambition. Management training programs are designed to stimulate and develop these qualities as the trainee "learns by doing." His training is always a fascinating challenge and he works with the best equipment and the finest people in the business.

James Chisholm is typical of the young men who rapidly rise to an important position at U.S. Steel. Jim came to U.S. Steel as a trainee in 1941 after graduating as an M.E. Shortly thereafter he entered military service for four years. Upon his return to U.S. Steel in 1946, he advanced steadily until, in 1951, he was appointed to his present position as Assistant Superintendent of Blast Furnaces at the new Fairless Works at Morrisville, Pa.

Jim is now in charge of the unloading of all ore ships and the operation of the plant's two big blast furnaces—each with a rated output of 1500 tons per day.

Jim feels that the opportunities for graduate engineers are exceptional at U.S. Steel. He remarked that in his own department alone, six college trainees have been put into management positions within the last couple of years. He says that chances for advancement are even better now with the current expansion of facilities and the development of new products and markets.

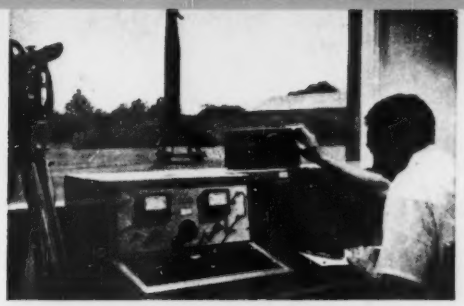
If *you* are interested in a challenging and rewarding career with United States Steel, and feel that you can qualify, you can get details from your college placement director. And we will gladly send you a copy of our informative booklet, "Paths of Opportunity," which describes U.S. Steel and the openings in various scientific fields. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

USS

UNITED STATES STEEL

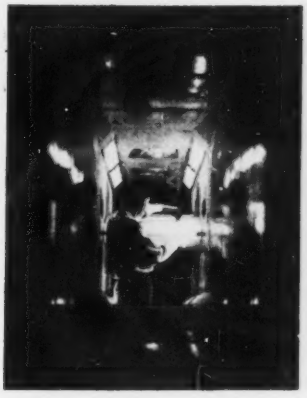
AMERICAN BRIDGE . . AMERICAN STEEL & WIRE and CYCLONE FENCE . . COLUMBIA-GENEVA STEEL . . CONSOLIDATED WESTERN STEEL . . GERRARD STEEL STRAPPING . . NATIONAL TUBE
OIL WELL SUPPLY . . TENNESSEE COAL & IRON . . UNITED STATES STEEL PRODUCTS . . UNITED STATES STEEL SUPPLY . . *Divisions of* UNITED STATES STEEL CORPORATION, PITTSBURGH
UNITED STATES STEEL HOMES, INC. · UNION SUPPLY COMPANY · UNITED STATES STEEL EXPORT COMPANY · UNIVERSAL ATLAS CEMENT COMPANY 5-690



Electronics Research Engineer Irving Aine records radiation antenna patterns on Lockheed's Radar Range. Twenty-two foot plastic tower in background minimizes ground reflections, approximates free space. Pattern integrator, high gain amplifier, square root amplifier and logarithmic amplifier shown in picture are of Lockheed design.

Jim Hong, Aerodynamics Division head, discusses results of high speed wind tunnel research on drag of straight and delta wing plan forms with Richard Heppe, Aerodynamics Department head (standing), and Aerodynamicist Ronald Richmond (seated right). In addition to its own tunnel, Lockheed is one of the principal shareholders in the Southern California Cooperative Wind Tunnel. It is now being modified for operation at supersonic Mach numbers.

Research Engineer Russell Lowe measures dynamic strain applied by Lockheed's 500,000 lb. Force Fatigue Machine on test specimen of integrally-stiffened Super Constellation skin. The Fatigue Machine gives Structures Department engineers a significant advantage in simulating effect of flight loads on a structure. Among other Lockheed structures facilities are the only shimmy tower in private industry and largest drop test tower in the nation.



C. H. Fish, design engineer assigned to Lockheed's Icing Research Tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has a temperature range of −40°F. to +150°F. and maximum speed of more than 270 mph. It is the only icing research tunnel in private industry.

Advanced facilities speed Lockheed engineering progress

Lockheed's unmatched research and production facilities help make possible *diversified* activities in virtually all phases of aviation, military and commercial.

They enable engineers to test advanced ideas which would remain only a conversation topic in firms lacking Lockheed's facilities. They help give designers full rein to their imagination. They make better planes — and better careers.

Engineering students interested in more information on Lockheed's advanced facilities are invited to write E. W. Des Lauriers, Lockheed Student Information Service, Burbank, California.

Lockheed

AIRCRAFT CORPORATION

BURBANK **California**

1927—Unloading cargo from Boeing mail plane

1955—Loading Boeing C-97 Stratofreighter

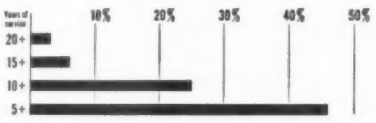
There's plenty of variety in Boeing engineering careers

America's pioneer passenger-cargo aircraft, the 40A, was a Boeing. So is the Air Force's versatile tanker-transport, the C-97 Stratofreighter shown above.

During the company's 38-year history, Boeing engineers have blazed new trails in the design of aerial freighters and tankers, commercial airliners, flying boats, fighters, trainers and bombers. Today Boeing continues to offer engineers a wide variety of opportunities in Research, Design and Production.

Students sometimes are surprised that Boeing's engineering staff includes those with civil, electrical, mechanical, aeronautical and other engineering degrees. Yet all find application in aviation. For example, the civil engineer may work on airframe structure or stress. Electrical engineers find challenge in the complicated electrical and electronic systems of modern jet bombers and guided missiles. Other engineers will find similar application for their talents.

The high degree of stability in careers at Boeing is reflected in this chart.



It shows that 46% of Boeing engineers have been with the company five or more years; 25% for 10 or more years, and 6% for 15 years.

Boeing promotes from within, holds regular merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expense.

Current Boeing programs include: six and eight jet bombers; America's first jet transport—the 707; F-99 Bomarc pilotless interceptor (guided missile)—and advanced projects such as the application of nuclear power to aircraft.

For further Boeing career information consult your Placement Office, or write:

JOHN C. SANDERS, Staff Engineer – Personnel
Boeing Airplane Company, Seattle 14, Wash.

BOEING

SEATTLE, WASHINGTON WICHITA, KANSAS

More and better jobs for more people

GENERAL MOTORS President Harlow H. Curtice speaking:

"Just as an example of how job opportunities in General Motors have grown, here is what has happened since 1940.

"In 1940, we had 233 thousand employes on our payrolls in the United States and Canada. In 1955, our employment totals 520 thousand —an increase of 287 thousand good jobs in only 15 years."

It stands to reason that a climate where job opportunities expand with such rapidity must be especially fruitful of career opportunities for young men holding engineering degrees.

For, in the final analysis, the very life's blood of our organization is the never-ending production of "more and better things for more people"—and that, very definitely, requires the engineering mind at its best.

In point of fact, although engineering graduates comprise a mere two per cent of total GM employment, they will eventually fill about forty per cent of executive posts if the established pattern continues.

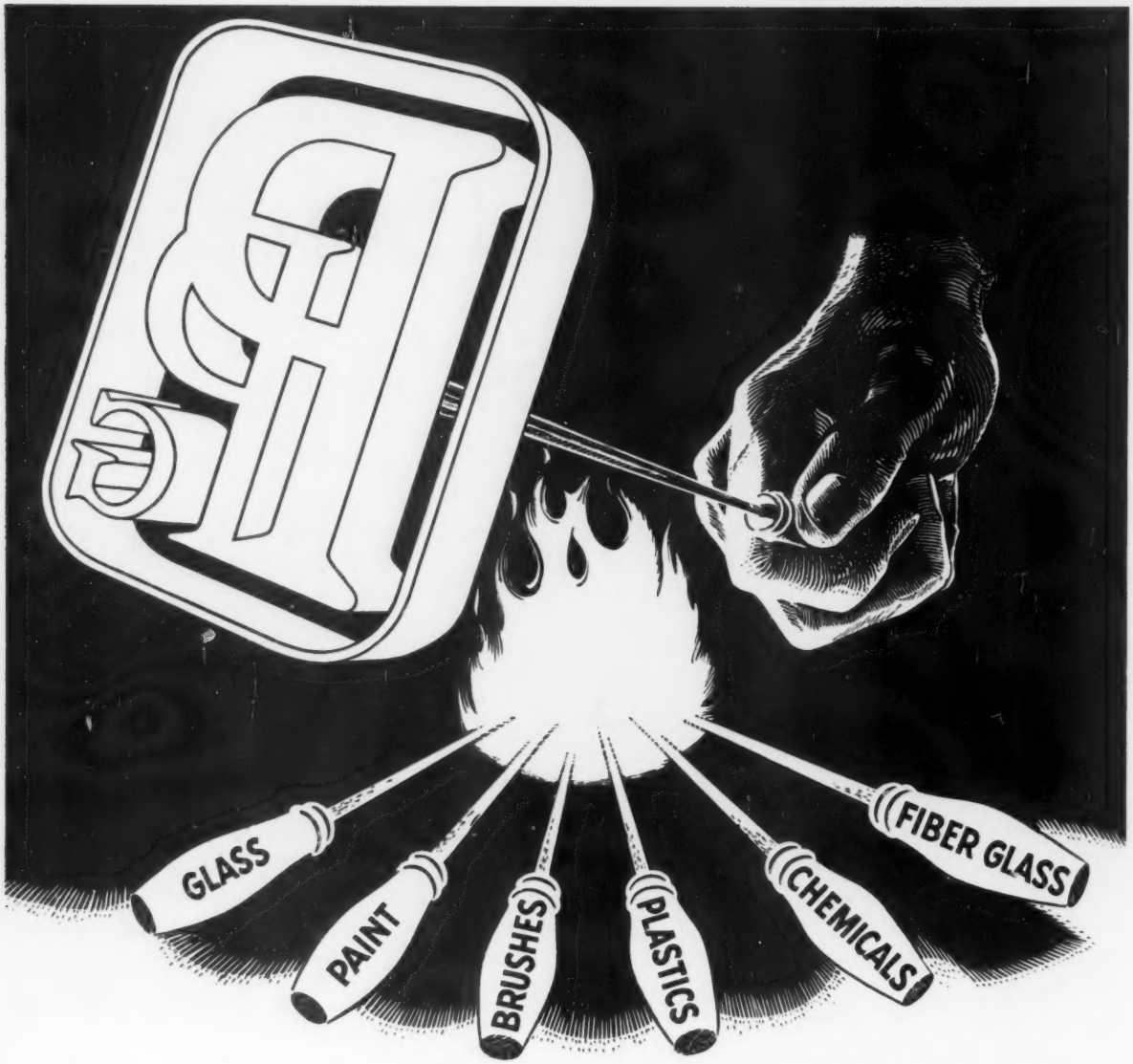
Why not, then, look into the possibility of enjoying a rewarding career as a GM engineer? You'll be interested in a big new 136-page handbook entitled, "Job Opportunities in General Motors." Your college library or placement office should have it.

GM Positions Now Available In These Fields:

MECHANICAL ENGINEERING
ELECTRICAL ENGINEERING
CHEMICAL ENGINEERING
METALLURGICAL ENGINEERING
INDUSTRIAL ENGINEERING

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan



PITTSBURGH PLATE HAS MANY IRONS IN THE FIRE

... maybe you should have a grip on one of them!

Although Pittsburgh Plate Glass Company is the best known name in glass, it is also one of the nation's leading producers of paints and brushes, of alkalies and related chemicals, of plastics and fiber glass.

These multi-industry operations offer the college graduate many and varied types of careers in manufacturing, research, marketing, sales and administration.

PPG's record is one of continual growth throughout its more than 70 year history. Its operations are nationwide and in many foreign countries. Progressive policies assure unlimited opportunities for alert men who are looking ahead to more than "just a job."

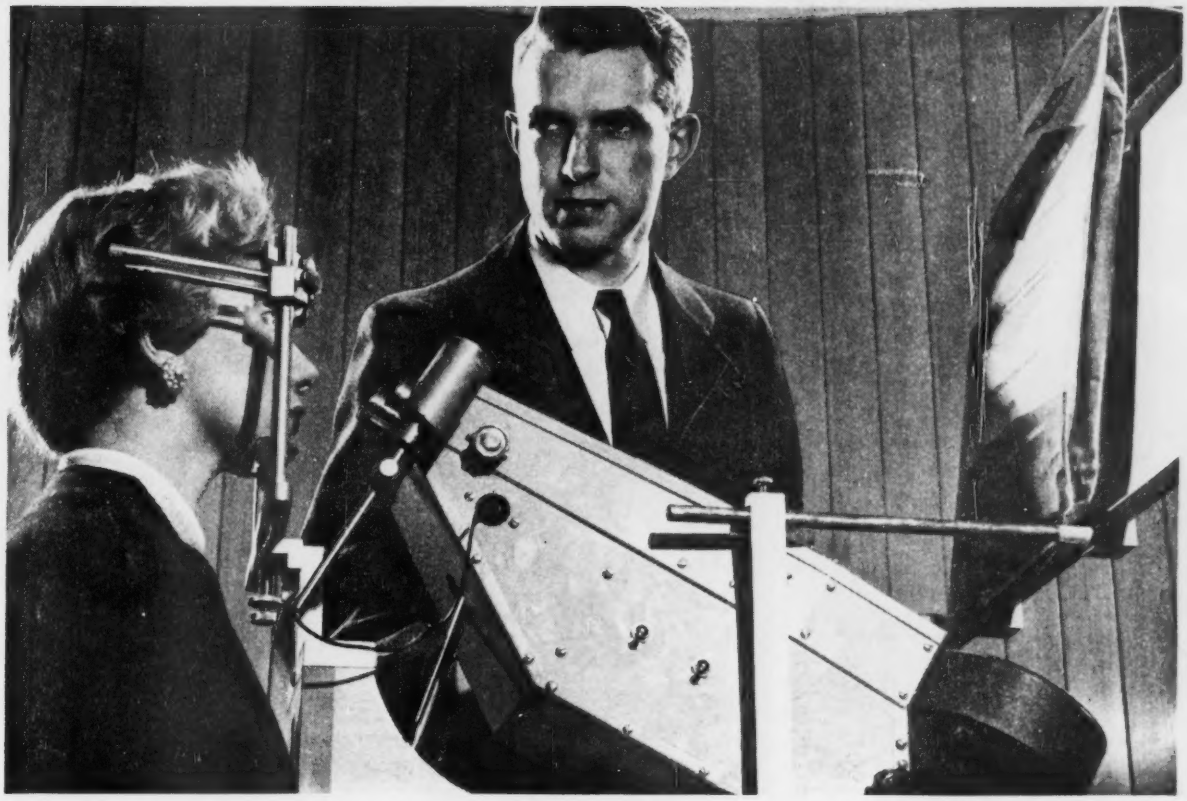
PPG is seeking good men with college training. If you think you'd like to try your "grip" on one of the many PPG "irons," you're invited to write today for more information. Just address: Pittsburgh Plate Glass Company, General Personnel Director, One Gateway Center, Pittsburgh 22, Pennsylvania.

PAINTS · GLASS · CHEMICALS · BRUSHES · PLASTICS · FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

319 PLANTS, MERCHANDISING BRANCHES, AND SALES OFFICES LOCATED IN 250 CITIES

DOW



MUCH MORE THAN MEETS THE EYE GOES INTO DOW PACKAGE DESIGN

Engineers and ocular cameras, salesmen, lawyers and artists combine talents to produce a unified "sales team" for Dow

Tin cans and tank cars, cardboard cartons and fiber drums, bags and bottles of sundry shapes, carry Dow products to world markets. In addition to quickly describing its contents, each package should speak for the product's quality and should reflect the company which produced it. Dow recently redesigned its packages with these objectives in mind.

Developing effective design while maintaining family resemblance for hundreds of Dow products was not an easy task. The abilities of hundreds of people and many machines were involved. Designers, engineers, salesmen, lawyers and artists all were called upon to contribute their particular knowledge.

An ocular camera played a vital role in choice of design. A subject sits before the camera and the test package is briefly exposed. Meanwhile, a moving picture is made of the subject's eyes. The picture is printed and played back, giving an accurate record of how the package was scanned. When analyzed, these pictures show which design elements dominated, the order in which the product message was read and so forth. The result—an accurate test of whether the package is doing its job, unimpaired by undependable personal likes and dislikes.

The design chosen and printed, thousands of packages leave Dow plants daily selling Dow quality and dependability to the world. Package design is a big job, yet it's but one step in a product's progress from research laboratory to customers' hands.

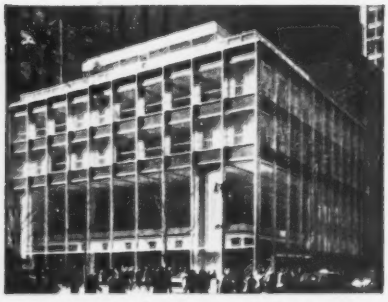
Whether you choose research, production or sales, you can find a challenging career with Dow. Write to Technical Employment Department, THE DOW CHEMICAL COMPANY, Midland, Michigan or Freeport, Texas for the booklet "Opportunities with The Dow Chemical Company" — you'll find it interesting.

you can depend on DOW CHEMICALS

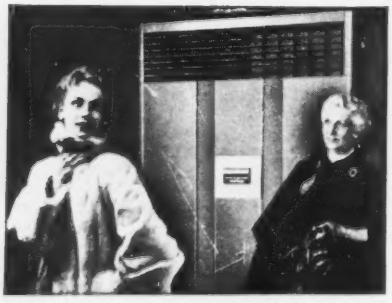
DOW

NEW PRODUCT in the air conditioning field is Worthington's ultra-modern winter and summer home air conditioner. It's a compact package that heats, cools, circulates, filters, and controls humidity. Like every Worthington product, this good-looking unit is designed and built for a lifetime of quiet, efficient service.

Making today's BIG news in air conditioning



NEW BUILDING in New York is the glass-sheathed Manufacturer's Trust Building. It's cooled by a Worthington central station system—so big it does the same job as melting 300 tons of ice daily.



NEW LIFE FOR OLD STORES. Shoppers stay longer, buy more in stores cooled by Worthington units with the new "Million Dollar" compressor. New 3-D circulation aims comfort right where you want it.

Worthington's new residential air conditioners, packaged units, big central station systems — all are making headlines in the air conditioning field. And the same research and engineering skills responsible for their development are applied to all Worthington products — engines, turbines, compressors, construction machinery, as well as pumps.

For the complete story of how you can fit into the Worthington picture, write F. F. Thompson, Mgr., Personnel & Training, Worthington Corporation, Harrison, New Jersey. 4.25D

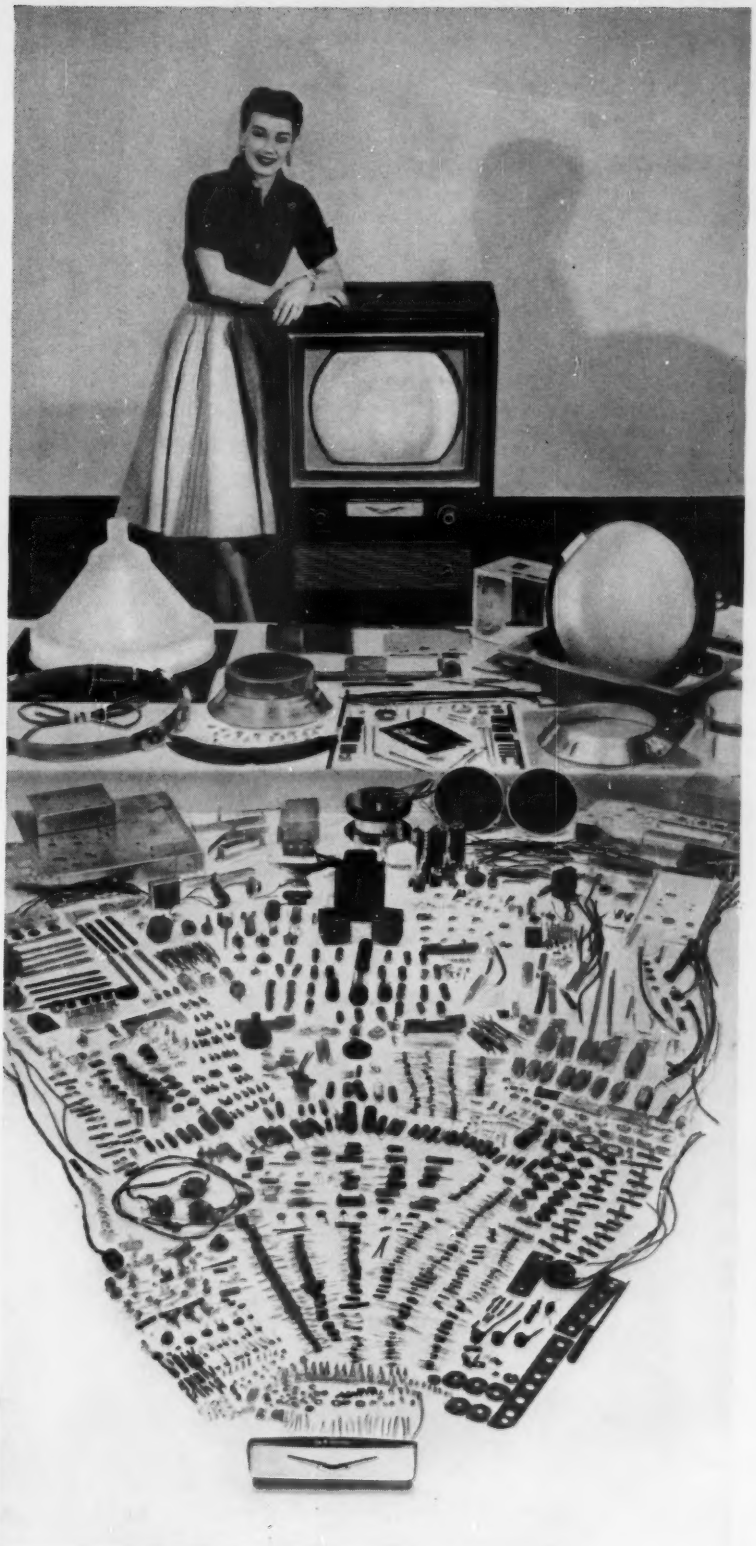
See the Worthington representative when he visits your campus

See the Worthington Corporation exhibit in New York City. A lively, informative display of product developments for industry, business and the home. Park Avenue and 40th Street.

WORTHINGTON

When you're thinking of a good job—think high—think Worthington

AIR CONDITIONING AND REFRIGERATION • COMPRESSORS • CONSTRUCTION EQUIPMENT • ENGINES • DEAERATORS • INDUSTRIAL MIXERS
LIQUID METERS • MECHANICAL POWER TRANSMISSION • PUMPS • STEAM CONDENSERS • STEAM-JET EJECTORS • STEAM TURBINES • WELDING POSITIONERS



This picture shows how RCA helps small manufacturers grow

Today the inter-dependence between manufacturer and supplier is stronger than ever in the history of American business. For in the challenging new age of electronics, hundreds upon hundreds of component parts are needed in the manufacture of new products.

For example, the superb new RCA Victor 21-inch color TV set shown here contains 2,070 parts. These are made by 600 different suppliers, most of whom are small businesses.

Indeed, more than three-quarters of all RCA suppliers are small business firms that receive nearly one-half of RCA's purchasing dollars. They, in turn, have their suppliers of raw materials. Thus through a long line of cooperative effort, employment is provided for countless people in many fields—and an entire economy benefits.

RCA salutes its full roster of 7,500 suppliers, located in 43 states, for their inventiveness and resourcefulness that contribute so much to the quality and performance of its products. With these firms at our side, RCA continues to march forward, creating new and better "Electronics for Living"—electronics that make life easier, safer, happier.

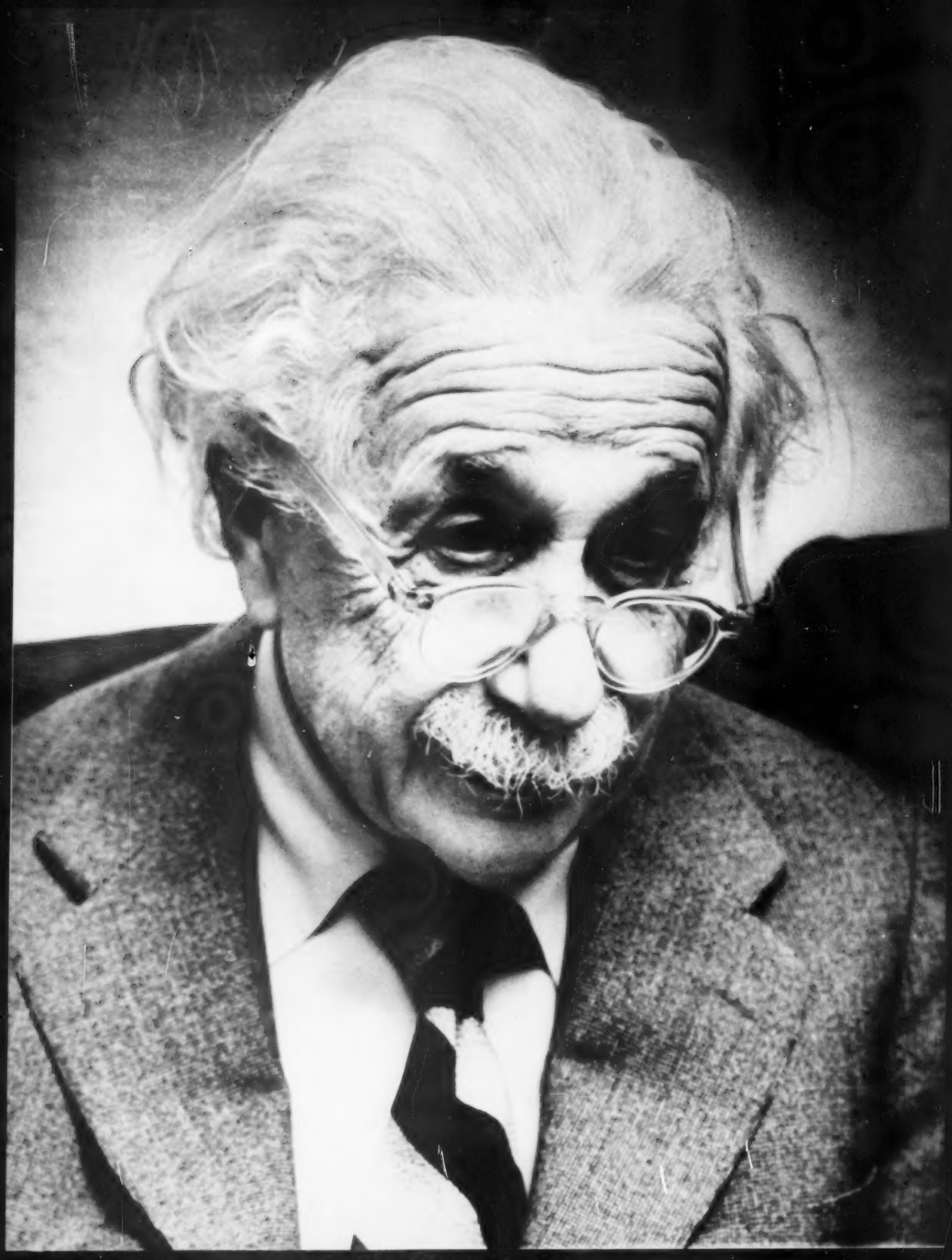
WHERE TO, MR. ENGINEER?

RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. For full information, write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

RCA®

RADIO CORPORATION OF AMERICA

ELECTRONICS FOR LIVING



Dr. Albert Einstein
1879-1955

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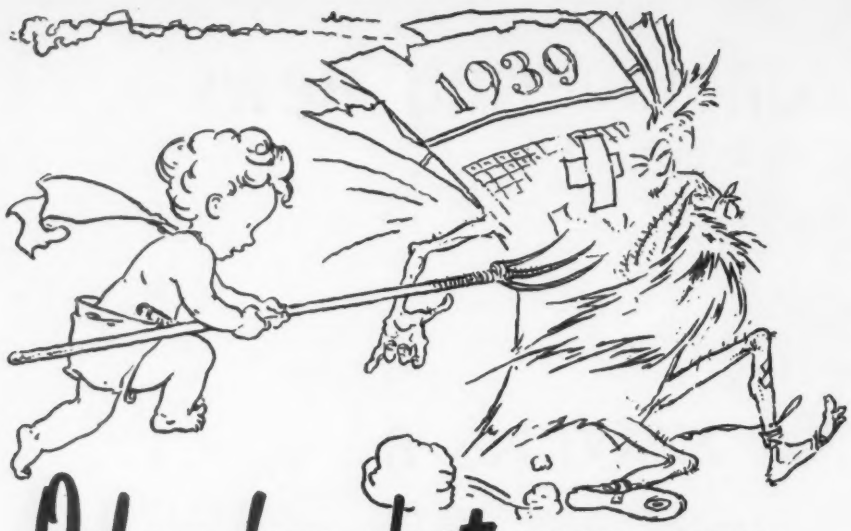
FRONTISPIECE

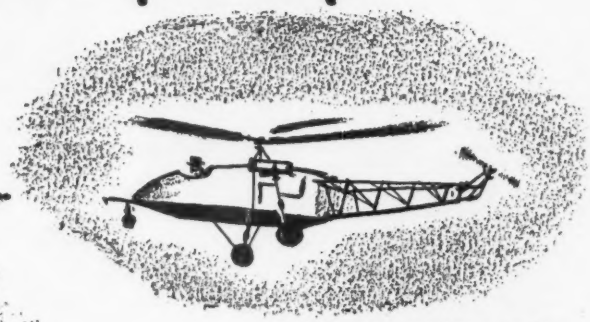
Hydroelectric Generating Plant

Published monthly during the school year at Walker Memorial, Cambridge 39, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Massachusetts under the Act of March 3, 1879. Copyright 1955 by The Tech Engineering News. Subscription per year $1.75. Foreign $2.50. One copy 25 cents.



Only a few short years ago

the helicopter was thought to be a "stunt" machine – amazing and amusing, and not particularly important. Events in Korea changed that idea – fast! This fledgling among aircraft performed "impossible" military assignments, spectacularly successful missions of mercy. Helicopters came into their own.



In 1939, the VS-300 with Igor Sikorsky at the controls made the first practical helicopter flight in the United States. Hundreds of later Sikorsky's were delivered for service in World War II.

Now in demand for hundreds of jobs, today's most versatile flying machine is the product of ceaseless testing, highest-calibre engineering, work and imagination.

Future Sikorsky's will be built by tomorrow's engineers. Perhaps *you* belong at Sikorsky where your skill and ability will be continually challenged.

You might find – in Sikorsky Aircraft's research departments, drafting rooms, engineering laboratories – a lifetime opportunity in this young, growing and most interesting field of aviation. Consult your College Placement Office concerning arrangements for a personal interview.

SIKORSKY

Sikorsky Aircraft, one of the divisions of United Aircraft Corporation, South Avenue, Bridgeport 1, Conn.

Wallace Barnes COMPANY

DIVISION OF ASSOCIATED SPRING CORPORATION

BRISTOL, CONNECTICUT

to the well too often

There are easier ways to get a drink.

And engineering graduates will be called upon to develop them. They'll have to help supply and distribute the billions of gallons of water needed daily by homes and industry. Water that will be increasingly hard to find.

But when they find it, they can rely on cast iron pipe to carry it. Practically every city in America — large or small — uses it for water and gas mains. In over 60 of them cast iron pipe has served for a century or more.

No other pipe can point to such a long and useful record of service to the nation.

CAST IRON PIPE RESEARCH ASSOCIATION

Thos. F. Wolfe, Managing Director, 122 So. Michigan Avenue, Chicago 3, Ill.

CAST IRON

CAST IRON PIPE SERVES FOR CENTURIES

legal aspects of patents

by Robert Heath '56

This article is designed for an audience of engineers and scientists, persons for whom a practical knowledge of patents will be useful in their professional work. It covers briefly the following main branches of patent law: the definition and purpose of a patent; the types of inventions that are patentable, and the procedure for obtaining a patent; and patent infringements and litigation.

Money involved to get a patent

A patent is, by definition, a contract between an inventor and the government, whereby the government agrees to guarantee to the inventor the exclusive enjoyment of his invention for a certain length of time. The inventor, in turn, agrees to disclose all the details of his invention immediately to the general public, and after a certain time to give up his privileged position of exclusive enjoyment of it. The ultimate purpose of the government in granting patents is not, of course, to enrich inventors, but to benefit the public by encouraging the inventor to use his device and to stimulate further discoveries by providing compensation for the time and effort put into making them.

Once the patent has been granted, it is the property of the inventor, and all laws relating to property apply to it. In particular, patents may be mortgaged, licensed, bought, and sold. For example, an inventor may buy someone else's patent if owning it would help him in making use of his own invention. However, sale of patents is subject to the terms of anti-trust acts, since monopolies against the public interest could be obtained in this way. It is frequently profitable to patent something which has no immediate value, in the hope that the patent may later be sold to someone who can make use of it. Again, an employee of a large corporation may agree by contract to sell his patent to the corporation, often for a nominal sum, since the corporation might make much better use of the patent than the inventor could on his own.

In some cases it may be profitable not to obtain a patent. For example, if it is desired to enjoy the invention for longer than a patent will last (patents have a life of seventeen years in the United States and there are no renewals), the details of the invention may be kept secret to prevent others from using it. As a striking example of this, the essential ingredient of Coca-Cola has been successfully kept secret since the 1880's, and its makers have profited tremendously as a result!

For a thing to be patentable, it must fulfill certain requirements as to subject matter, it must be an invention, it must be new, and it must be useful in some way. Each of these conditions will now be taken up in some detail.

First, the thing to be patented must fall within one of the following categories:

1. A composition of matter. This may be either a chemical or a mixture of materials like a rubber cement.
2. A process. This has been defined as "an invention which requires that certain things be done with certain substances in a certain order." For example, tanning, vulcanizing, and smelting are processes.
3. A machine or apparatus. This category includes laboratory apparatus and testing equipment. An arrangement of equipment for performing a certain function may also be patented as a machine.
4. An article of manufacture. This is different from a composition of matter in that it has a certain arrangement of configuration. The distinction from a machine is less sharp; in manufactured articles there is usually no relative mechanical movement of the parts, or else such movement is not complicated, while a machine generally involves complex mechanical movements. Thus, a rotary can-opener would be classed as a manufactured article rather than as a machine.
5. An ornamental design for a manufactured article, which possesses both originality and beauty. These patents, unlike others, are issued for a term of 3, 7, or 14 years, at the option of the inventor. A typical design patent is shown in Figure 1.
6. A distinct variety of plant asexually reproduced, other than a tuber-propagated plant.

It is well to mention also certain classes of things which have been declared unpatentable. Among these are:

An idea or mental concept not applied to a practical purpose.

A principle of nature, since no one can claim an exclusive right to it. Invention lies not in discovering principles, but in applying them to useful objects.

A system of doing business, such as an accounting system.

A mental process.

An arrangement of printed matter.

A method of treating the human body, as by medicine to cure a disease. Morton, the discoverer of the anesthetic properties of ethyl ether, was denied a patent for administering it, since his process consisted merely of applying a well-

UNITED STATES PATENT OFFICE

168,334

TEAPOT OR SIMILAR ARTICLE

Charles H. Newman, Northfield, and James L. Hvale, Chicago, Ill., assignors to Teamakers, Inc., Chicago, Ill., a corporation of Illinois

Application August 6, 1952, Serial No. 20,930

Term of patent 14 years

(Cl. D46—28)

To all whom it may concern:

Be it known that we, Charles H. Newman and James L. Hvale, both citizens of the United States of America, and respectively residing at Northfield and Chicago, county of cook, State of Illinois, have invented a new, original, and ornamental Design for a Teapot or Similar Article, of which the following is a specification, reference being had to the accompanying drawing, forming part thereof.

Fig. 1 is a side elevational view of a teapot or similar article, showing our new design.

Fig. 2 is a similar view of the article when turned from right to left through an arc of 90 degrees about its upright axis relative to the position thereof shown in Fig. 1.

Fig. 3 is a top plan view thereof.

We claim:

The ornamental design for a teapot or similar article, as shown.

JAMES L. HVALE.
CHARLES H. NEWMAN.

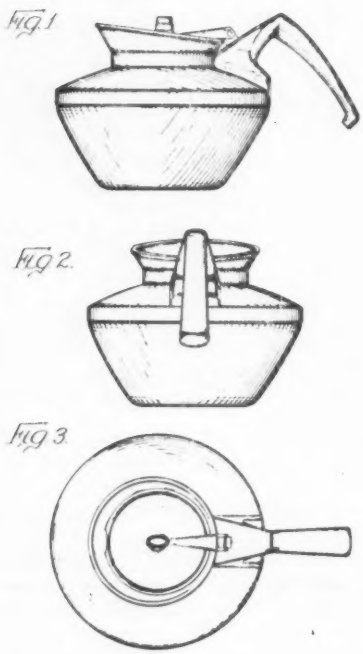
REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
D. 24,238	Butler	Apr. 23, 1895
D. 90,884	Hadley	Oct. 17, 1933
D. 140,444	Kaiser, Jr.	Feb. 27, 1945
D. 167,645	Newman et al.	Sept. 2, 1952

Above—Design specification for teapot or similar article. Below—Drawing showing the outward appearance of the teapot incorporated in the design specification.



known agent, ether, by well-known means, inhalation. The fact that people could be conveniently operated on while under its influence was a principle of nature and hence unpatentable. However, if the mode of treatment is by some mechanical means such as injection, rather than by an ordinary bodily process like inhalation, it may be possible to obtain a patent for it.

Inventions involving atomic energy, formerly unpatentable, have been largely restored to the patentable category by the Atomic Energy Act of 1954.

An effect or result of a process, since this would give the inventor a monopoly over all possible ways of achieving the effect, and not only over that way that he himself invented.

Second, the thing must be an invention; that is, its development must not have been obvious to a person having ordinary skill in the field concerned. Invention constitutes the foundation of the right to obtain a patent; it also presents the most difficult legal question of all, since "invention" cannot be defined in a useful manner. Some examples, however, may serve to clarify the situation: The use of liquid glue in place of dry glue does not constitute an invention, since anyone commonly occupied with gluing might have thought of making liquid glue. Similarly, putting sound tracks and motion picture frames on a single film, spot welding, and safety razor blades are not inventions. Some useful criteria in cases of doubt are as follows: the thing should fill a long-felt need, it should lead to commercial success, and it should provide a solution to a long-standing problem. None of these qualities is sufficient in itself to determine whether or not something is an invention, since, for example, an intensive advertising campaign might make a commercial success out of something that was not an invention at all, and had been thought of many times before by persons who had not bothered to promote it.

Some other interesting points may be brought up with respect to invention. After much discussion, it was decided recently that it is not necessary for an invention to stem from a "flash of genius" to be patentable; the method of discovery is immaterial. Only the result is judged in awarding patents. It is not necessary that an inventor should understand the scientific principles underlying his invention. The invention does not need to be brought to its highest state of perfection, but it must be able to perform, at least crudely, the function for which it was designed. An improvement on a previous device, which involved inventiveness in its development, may be patented. However, change in form, mind, or immaterial features does not involve invention, and is hence unpatentable. If a well-known machine is put to a new use not analogous to that for which it was originally intended, the new use may be patented. Similarly, bringing old and well-known

parts together to perform a new use, or to perform their old use more advantageously, is patentable. Consider, however, putting a rubber eraser on the end of a lead pencil; this is not an invention, since no new use is effected by the combination.

Third, the invention must have novelty. The fact of an invention's having gone into general use may be used as evidence of its novelty, although again, as in the case of invention, this evidence cannot stand by itself.

The following criteria are used in determining the novelty of an invention:

1—If a patent was issued on the same invention in the United States or in any foreign country prior to the time the inventor made his invention, or more than one year before he filed an application for a patent on it, his invention is unpatentable.

2—If an application was previously made for a patent on an invention, but no patent was issued, the inventor may reapply if he wishes.

3—If the invention was described in a printed publication in the world before the inventor made his invention, or more than a year before he applied for a patent, his invention is unpatentable.

4—If the device was generally known or used in this country by others before the inventor developed it, or more than one year before he applied for a patent on it, it is not new and cannot be patented. Thus, if the inventor himself had been selling the device more than a year before he applied for a patent, he could not obtain one. However, prior knowledge and use in a foreign country is not considered to negate novelty. Such prior use must have been successful, and must have been publicly known, in order to prevent issuance of a patent to the inventor. The above-mentioned cases of previous application for a patent and prior description in a printed publication may apply here as giving evidence of previous knowledge and use.

Finally, the invention must have some utility not immoral or injurious to the health or good of society. This utility for a particular purpose must be demonstrated to the satisfaction of the person issuing the patent. Once again, if the invention has gone into general use, it must be useful, and this may be used as evidence of its utility.

To obtain a patent, an inventor must file a written application

Examples of invention and superinvention.

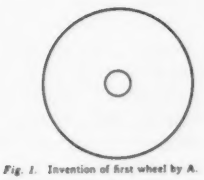


Fig. 1. Invention of first wheel by A.

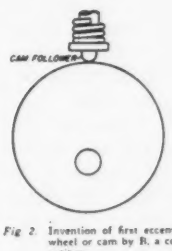


Fig. 2. Invention of first eccentric wheel or cam by B, a competitor.

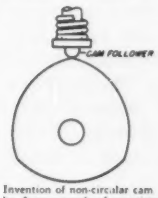
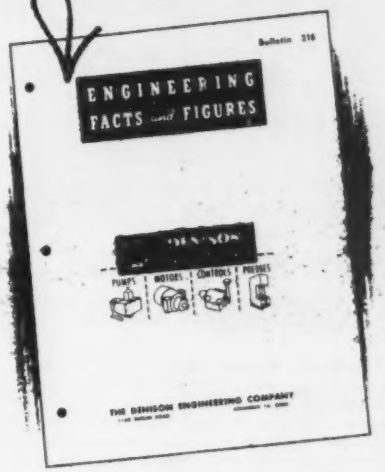


Fig. 3. Invention of non-circular cam by A as a result of superinvention.

Fig. 4. Gear wheel invention by A as a result of superinvention.

Free facts and figures for engineers



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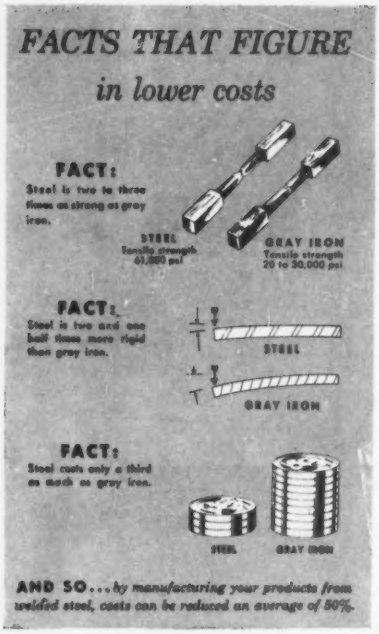
FACTS THAT FIGURE
in lower costs
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Steel is two to three times as strong as grey iron.
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Tensile strength 20 to 30,000 psi
FACT:
Steel is two and one half times more rigid than grey iron.
STEEL
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FACT:
Steel costs only a third as much as grey iron.
STEEL
GRAY IRON
AND SO... by manufacturing your products from welded steel, costs can be reduced an average of 50%.

HOW PROPER DESIGN CAN LOWER COSTS

● When you design properly for steel construction, your products will always cost less to manufacture. Because steel is two to three times stronger than cast iron, and 2½ times as rigid, fewer pounds of metal are needed. Also, each pound of material costs a third as much.

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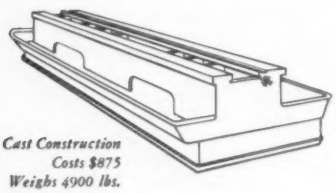
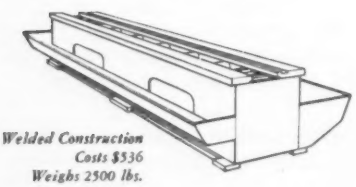


Cast Construction
Costs $875
Weighs 4900 lbs.



Welded Construction
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Weighs 2500 lbs.

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with the Commissioner of Patents, whose office is in the Patent Office in Washington. A patent application is one of the most difficult papers to prepare, since every statement in it must be as accurate as possible. The description of the invention must be sufficiently complete and detailed to enable any person skilled in the field to use the invention, working from the description in the patent. Any trade-mark used in the construction or operation of the invention must be described completely. If such description cannot be given, no patent can be issued for the invention. This description is required in order that the public may be able to use the invention after the patent has expired, according to the terms of the contract.

In addition to the description, the inventor must list what he claims for the invention, both as to what was inventive and new in its development and as to what it may be used for. If he claims too much, his patent will not be granted. On the other hand, if he claims too little as to its usefulness, he may find himself with a patent that will not protect him from infringement.

Returning to the process for obtaining a patent: the Commissioner refers the application to an examiner, who will probably reject it several times on grounds of lack of novelty or invention. After each rejection the inventor (or probably his attorney) is expected to respond to the objections of the examiner in order to satisfy him that a patent should be granted. If two persons claim the same invention, it may be necessary to institute an interference, which is a suit in equity to decide who was the first inventor. If, after the examination is completed, the Commissioner refuses to grant a patent, the inventor may appeal to the Court of Customs and Patent Appeals. (The Supreme Court has no jurisdiction in such cases.) However, such proceedings are expensive, and it is generally preferred to revise the application in accordance with the Commissioner's suggestions, or else to abandon it completely.

A trespass on the property rights of an inventor in his patent, that is, the unauthorized manufacture, sale, or use of his invention within the United States, is known as an infringement.

A process may be infringed by another process resembling it in every essential detail. Similarity of product however is not sufficient to constitute infringements.

A patent for an improvement in an earlier invention does not license an inventor to make use of that invention if it is still protected by a patent; it does, however, prevent anyone else, including the person enjoying the use of the earlier invention, from making use of his improvement. A difficulty of this sort may be resolved by one party's selling or licensing his patent to the other.

As has already been mentioned, the claims in a patent determine what constitutes infringement of it. Great pains are taken in drafting an application, to find just what sort of thing is liable to infringe the original invention, and to include such things in the claims. This process is known as "superinvention." For example: suppose A's invention is the first wheel, and he describes it in his application as "a circular body having a central axis and adapted to be mounted on an axle . . . ," and while his application is pending, B begins producing an eccentric wheel. A recognizes that B's wheel would not infringe his patent, and amends his application so as to omit the word "central." Subsequently A hits upon the idea of a non-circular wheel, or cam, and revises his application again to substitute the word "annular" for "circular." A gear would also fit this last description, and if A had this in mind, his patent would cover this also; if, however, gears did not occur to him, then his claims would be too broad, and any patent he might obtain would not be valid. Note also that A must describe the usefulness of his invention, and if the idea of using a noncircular or eccentric wheel as a cam to impart transverse motion to a follower did not occur to him, using one for such a purpose would be an invention itself and would not infringe on his patent!

If a court declares one claim in a patent invalid, the entire patent is not necessarily invalidated, although what is left may not be worth much. Therefore, it is sometimes the practice in drafting an application, to make a series of successively broader claims, so that if the broadest ones are later invalidated, there will be something to fall back on.

If a patentee believes his patent is being infringed, he may bring a suit against the infringer in a Federal District Court. In such cases the plaintiff is always the person whose patent is being infringed, and the defendant is the person allegedly infringing it. The United States government cannot be sued in such cases without its own consent. The plaintiff bears the burden of proof that his patent rights are being invaded. The defense frequently takes the position that the plaintiff's patent is invalid, particularly on the grounds of want of novelty. The burden of proof of this is in the defendant, and every reasonable doubt will be resolved against him. The court may declare the patent invalid on grounds of want of novelty or invention, even though this is not part of the defense's case. Hence much more usually depends on the outcome of a patent litigation than the mere payment of damages; the plaintiff is liable to lose his patent if it was wrongly granted. The following are considered admissible evidence in patent suits: declarations by the patentee of his belief that he was the first inventor, testimony of experts in the field to which the invention belongs, prior patents, and other indications of the prior state of the article, such as printed publications.

If the defendant is found guilty of infringing, the compensation he is required to pay the plaintiff depends on the type of suit that was brought. In a case at law, the defendent must pay damages with interest, where "damages" is the amount the owner of the patent lost by reason of the infringement. In a case at equity, which is brought if the law is deficient on the point in question, the defendant is liable for "profits," or the amount he himself made by infringing; no interest is paid in this case. Profits are paid in a case at law only if damages cannot be accurately evaluated. In any case, the plaintiff cannot collect court costs from the defendant. The defendant, if found guilty, is enjoined from continuing to infringe the patent. If either side is dissatisfied by the outcome of the trial, he may appeal to the Circuit Court of Appeals, and from there to the Supreme Court.

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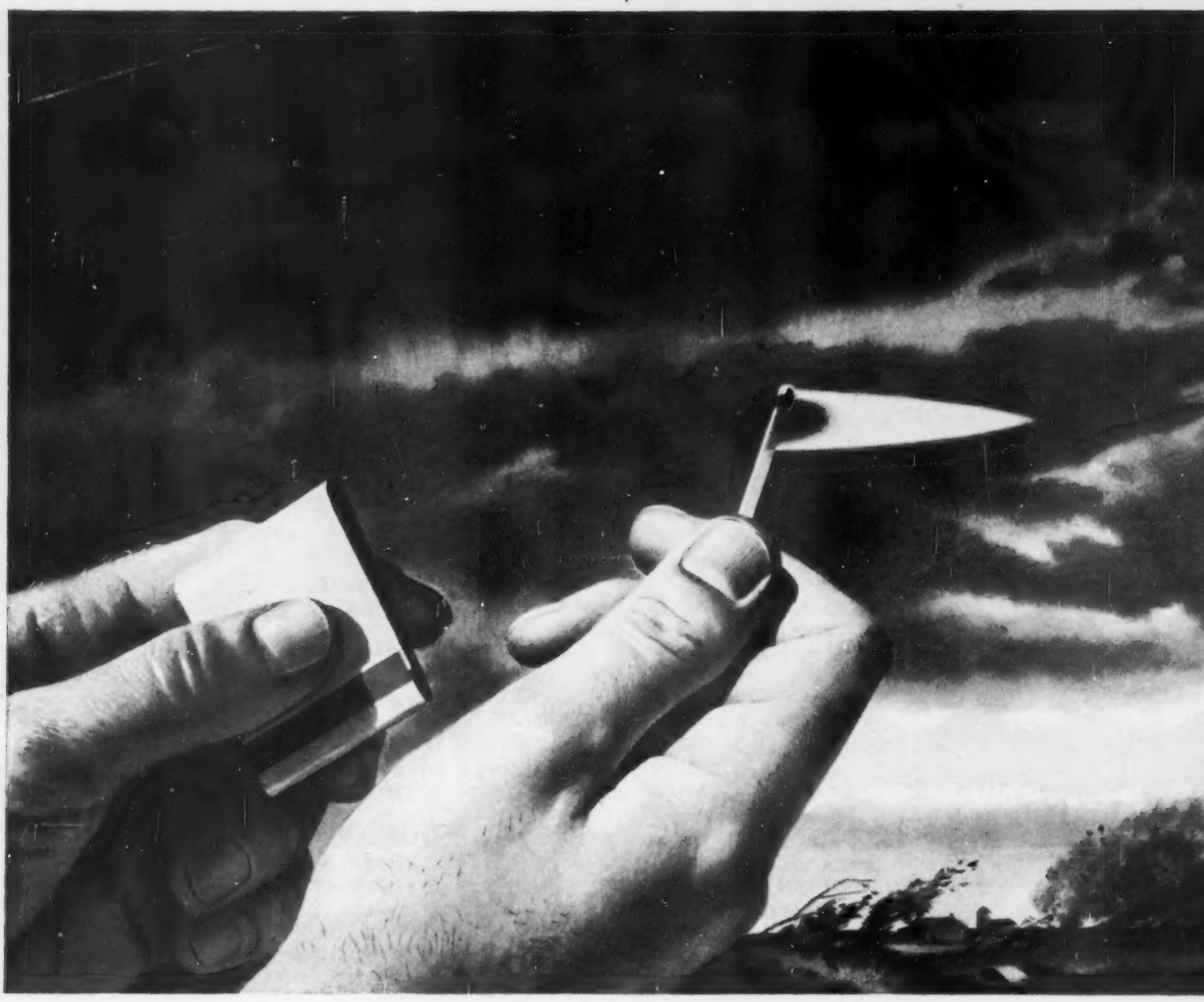

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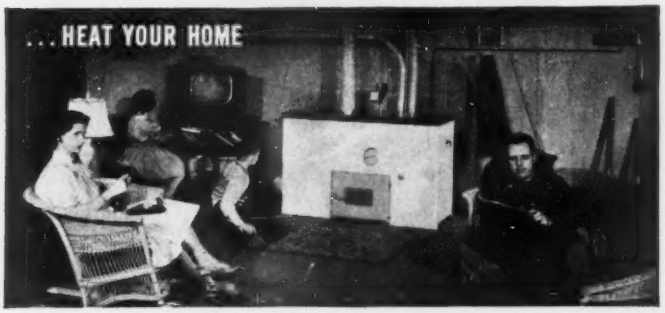

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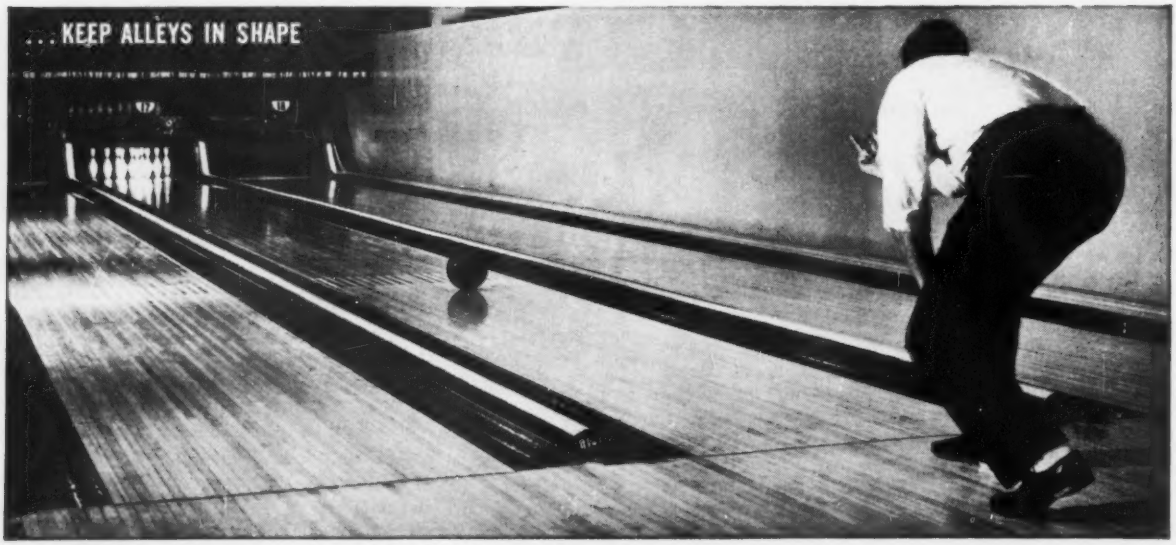

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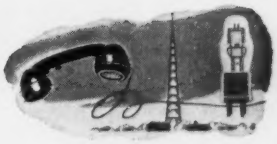

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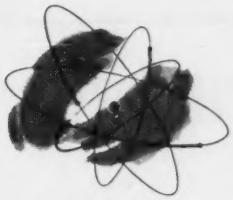

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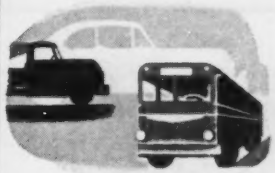

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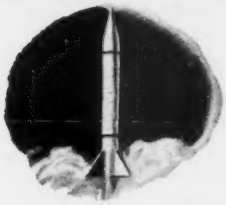

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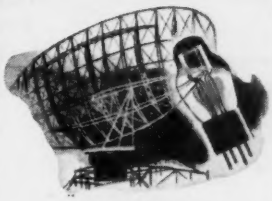

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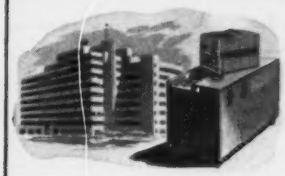

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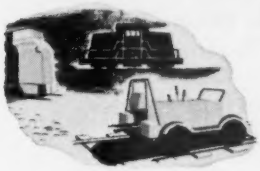

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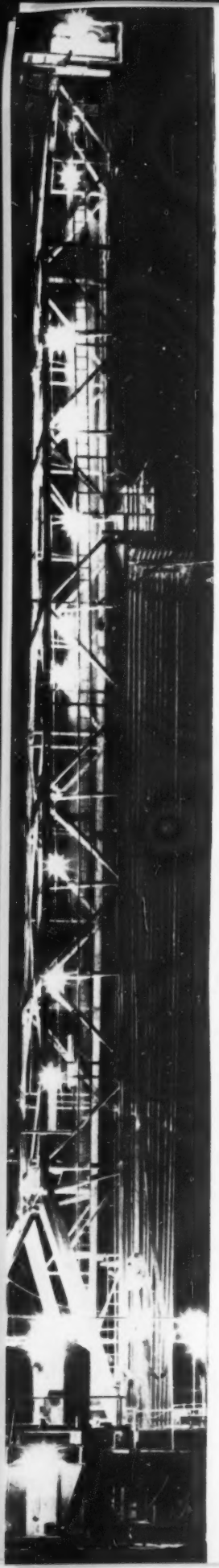

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from the editor's notebook

Taking over the responsibilities of the new Junior Board are seven men whom the new Managing Board feels will keep up the precedent set by T.E.N. Steve Newman '56 moves up from Sales Manager to share with Barry Mazur '58 the responsibility of Literary Associate. Herb Schwarz '58 will keep the advertising records as Advertising Manager. Planning the layout will be Jim Graham '58 as he takes over the position of Make-up Editor. Continuing in the art department will be Bill Walsh '57 who has already proved himself to be one of the best in T.E.N.'s history. The various photographic jobs will be handled by Jarda Polak '57. And moving up from the staff to Circulation Manager is Roger Wollstadt '58. The new Managing Board wishes the new Junior Board the best of luck in the coming year.

The Managing Board, Junior Board, and Staff of T.E.N. is happy to announce that as a fitting climax to a fine year, all receipts of the May sales will go to CARE.

A. C. L.

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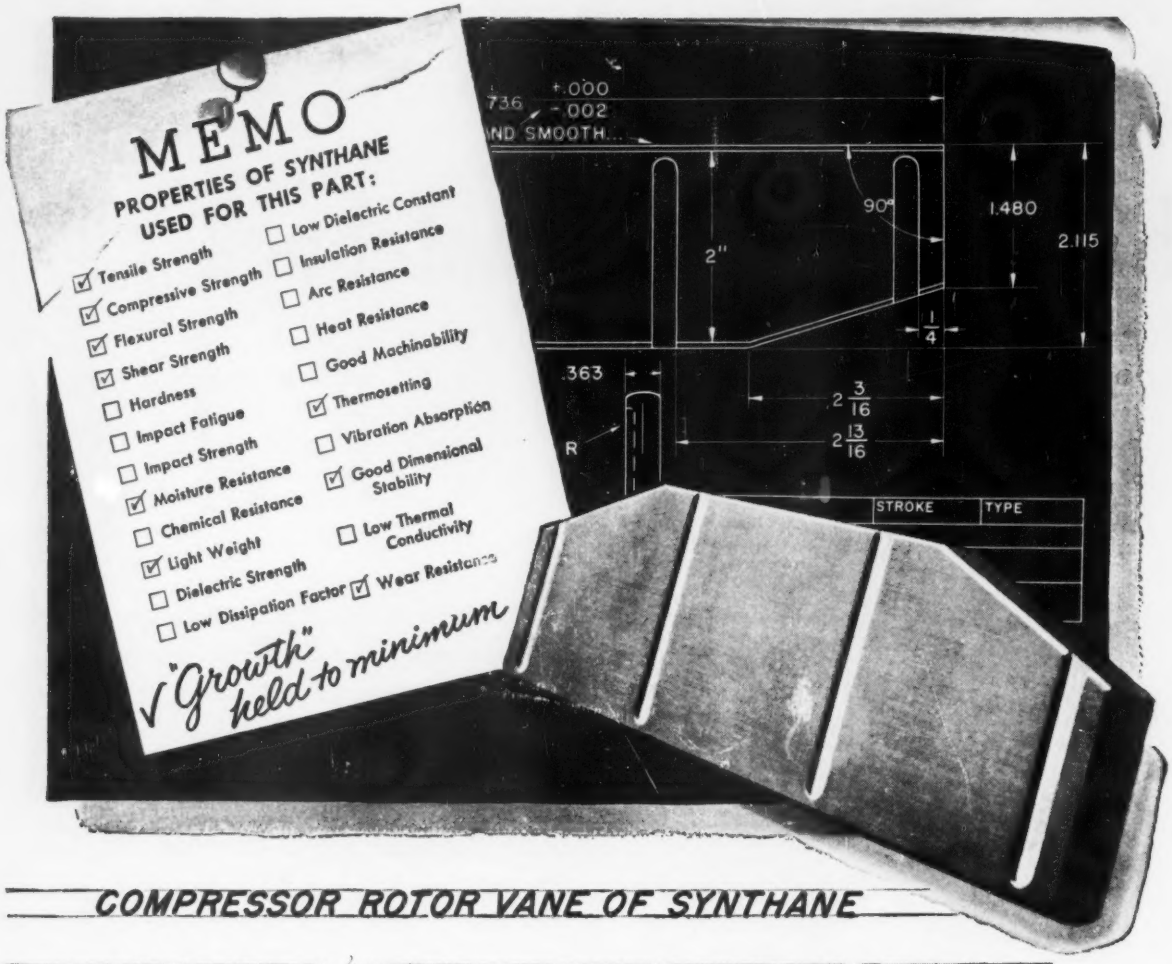

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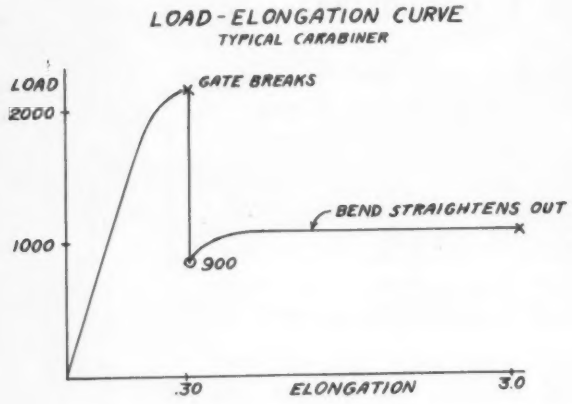
mountaineering equipment-- the safety factor

by Ritt Walling '56

Mountaineering safety equipment is somewhat of a paradox; it is made to traditional design by craftsmen of little or no engineering training; it is treated roughly in use, and subjected to extremes of temperature and weather; it is desired to be as lightweight as possible, yet, when its moment comes, it is expected to withstand heavy shock loads and to do this reliably, for the climbers' lives depend on it.

Tested in the M.I.T. Materials testing lab were the following:

1—Bedayn Duraluminum Carabiner
2—U.S.A. Steel Oval Carabiner



3—Swiss Steel "D" Carabiner
4—Hand Made Piton (author's) with Brazed Ring (steel)
5—Steel welded ring of low quality
6—Brazed ring (steel, author's)

These articles of equipment receive use, in general, as follows: The leader (first man to ascend) drives the pitons into small cracks in the rock at intervals of from 5 to 50 feet, depending on the difficulty of the climb. When hammered in hard, the piton is wedged tightly into the crack; to pull it out requires up to 7,000 pounds of force. The leader's rope is then fastened to the piton's ring by means of the *carabiner*, or snap-link. The rope is held below by the second man to ascend, who releases it as the leader climbs. If the leader falls, the second man must hold him by the rope, easing it so that the shock upon the rope's tightening is reduced. Since the rope goes up to the caroliner, 180 degrees around it, and down to the falling leader, it is easy to see that, neglecting friction, the force on the piton and caroliner is double that on the leader. Wexler gives 1750 pounds as the maximum force which the human at the end of a rope can withstand. If we double this, we get 3500 pounds as the maximum possible lead upon the caroliner and piton. The tests were run to determine experimentally whether common equipment could be trusted to withstand this load.

Procedure

A universal hydraulic testing machine was fitted with a set of vise-jaws, which gripped steel u-bolts 7/16" diameter. The carabiner was placed in the u-bolts and pulled in tension (see figure 3). The Piton rings were pulled in the same manner, and the piton itself was placed in the jaws, with a u-bolt through the ring.

Results

Table I

Item	Fracture	Yield	Description of Fracture
Bedayn Al Carabiner	2300	1280	2200 pounds gate catch bends. Gate catch breaks. Yield strength is const. until end of test.
U.S. Army steel oval carabiner	1500	900	Failure occurred in gate hinge (hot pin). 100 lbs. const. to end of test.
Swiss D	2280	950	Failure was same nature as U.S. Army carabiner. 950 lbs. constant to end.
Brazed ¼" piton ring weld on the u-bolt	2800 max.	1000	1000 lbs. starts to yield. Loaded to 2800 then turned sideways, where bending brought quick weld fracture.
Piton Braid Ring Weld at side.	4500	1000	1500 ½ oval fracture due to neck in the iron.
Bad weld ring	1300		Failure in a very poor iron weld.

Table 2

Item	Ultimate St. Advertised and calculated	actual	Strength with gate open
Bedayn	3500	2300	1280
U. S. Army	2300	1500	900
Swiss D	2800	2280	950
piton rings brazed ring	2800	2800 max.	did not fracture
piton with brazed ring	2800	4500	weld did not break
ring with bad weld	500	1300	

The results of these tests show several points of interest to the climber. Carabiners have considerably less strength than advertised, and extremely low strength when the gates are open. See Table 2.

The piton rings showed a much higher strength than calculated on the basis of the strength of the bronze welds.

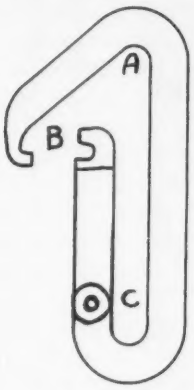
Stress Analysis

A Piton Rings

Due to the extreme ductility of the steel used for these rings, and the special used to weld them, the following ultimate shape was assumed (fig. 4). The load divides up so that p/2 is exerted on the weld section using and 40,000 psi min UTS. For the brazing spelter, 2800 lbs.=P ult.

Theoretical stress analysis for Bedayn Aluminum carabiner.

R=Radius to center line in
O=Angle, meas. clockwise. Rad
D=Diameter of section, degrees
M=Bending moment about in-lbs.
A=Area of cross section in squared
F=Force normal to radius
S=Stress normal to radius



First we must find the location of maximum stress:

Moment:

$M = PR \sin\Theta$

$F = P \sin\Theta$

$S = (P/A) \sin\Theta$

To maximize, take derivatives:
(formulae)

$$\frac{dM}{d\theta} = PR\cos\theta$$

$$\frac{dS}{d\theta} = \frac{P}{A}\cos\theta$$

$$M_{max} = PR \quad S_{max} = \frac{P}{A}$$

A calculation based on straight beam proved to give incorrect results. Timoshenko gives the following formula, in bent Beam calculations.

for y :

$$\bar{y} = R - \frac{A}{\int \frac{dA}{V}}$$

where R is the radius to the centroid of the section; y is the distance from the centroid to the neutral axis, and V is the distance from the center of curvature to any elementary area inside the cross section.

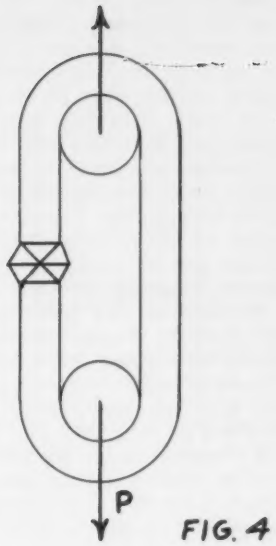


FIG. 4

Timoshenkos Formula for the fiber stresses in such a bent beam is:

$$S_{x\,MAX} = \frac{M h_1}{A \bar{y} a}$$

where a = inside radius of bent beam, and h = distance from neutral axis to inmost fiber.

Inverting the dimensions into this equation yields the final stress equation:

$$S_{x\,MAX} = 15.4\,P$$

Sx being in the inside of the curve at O=90 degrees.

Using Timoshenkos value for the dural alloy carabiner we get Pgs=1300 lbs. If 2 c—St—3 Aluminum alloy were substituted, (50,000=syp). The yield load would be 3200 lbs.

Ref: Timoshenko, Elements of strength of materials.

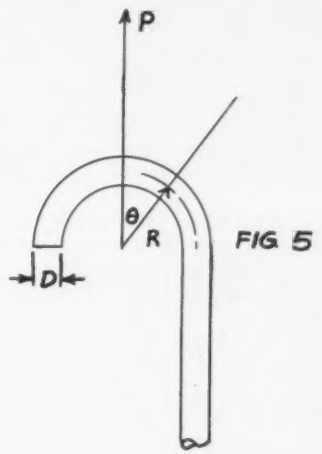


FIG 5

Discussion and Explanation of Test Results

In the test of the aluminum carabiner, the back of the carabiner remained straight throughout the test, while the top bend unwound itself around the u-bolt. Inspection showed that all of the yielding, accompanied by some necking, occurred at the base of this bend, just as theory predicted it to be. The yielding criterion was taken to begin after the gate had broken, since the carabiner showed no visible deflection before this. The discrepancy between calculated yielding, 1300 lbs., and actual yielding, 1100 lbs. can be explained by 1 inaccuracy in bent-beam assumption—the yield actually occurs in a transition—one between bent and straight beam section. 2—Inaccurate value for yield strength—Timoshenkos value was for an average alloy. 3—Aluminum does not show a sharp yield strength anyway, so yielding strength is taken on the stress at a certain 1.2% permanent deformation. 4—neglect in allowing for a flat spot which reduced the section in this zone.

In spite of this, it may be noted that the formula puts us in the right ball park, with 18% discrepancy.

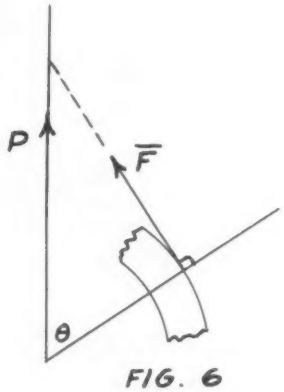


FIG. 6

While the gate remained closed, it was responsible for over ½ of the strengths of the carabiner. This fact is very important to the climber, who must not let the gate open (if he values his life, that is).

The U. S. Army and Swiss D carabiners failed in approximately the same manner (after the gates were broken) at first, but as strain hardening made their bends stronger, bending took place in the middle of the back. The gates of these carabiners showed no deformation until the hinges broke, not in the pins but in the body of the carabiner itself. A sharp notch into which the spring fitted served as a stress raiser in an already weak section in both carabiners, and probably initiated failure.

In the piton ring tests, the validity of the shape assumption of Fig. 4 was proven. Since the brass welds were of greater section than the ring itself, and were ductile enough to assume max. tensile stress uniformly across their section, they proved stronger than the steel, and the weld breaking criterion proved to be very conservative. In the piton test, the ring started necking where it was notched slightly by the sharp corner of the piton hole.

The extremely low failure of the bad iron-welded ring, while a ductile failure, paints up the serious weakening effect of cracks, pits, etc. in iron welds. Piton rings cannot be reliably welded by ordinary electric arc methods because of the difficulty of getting proper penetration and purity of weld metal.

Improvements and Suggestions

The test series showed that there is considerable improving to-be done in carabiners. This problem can be tackled by three approaches:

1—Design of the geometric shape of the carabiner so that lower bending stresses are developed. Many of these efforts have yielded monstrosities which are inconvenient, hard to handle, and of doubtful value. (See fig.).

If the rope is at A, piton at C, then the carabiner is on improvement. If it should be that B and C are centers for pull, the situation is much worse than for a plain oval.

2—While keeping the oval shape, adding more metal to the catch and hinge, of the gate, and

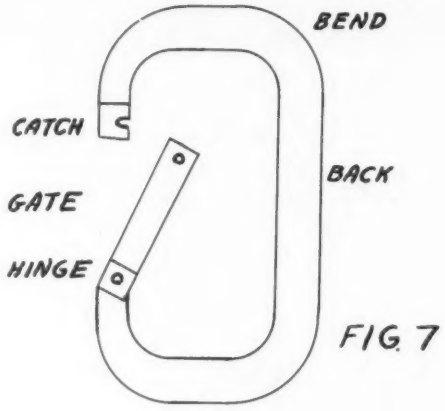


FIG. 7

avoiding the sharp notch for the spring should raise the strength of the whole carabiner appreciably.

3—The third approach is to use stronger metal in the carabiner. For instance in the Bedoyn Aluminum carabiner, if 24ST—3 Aluminum alloy had been used to make a unit of exactly the same dimensions then the theoretical gate-open yield load would be 3240 lbs. Obviously this type of improvements would be a real advance, since it would render the carabiner safe even with the gate open.

A carabiner with the gate open can support little more force than that encountered in a jerky rappel (600 lbs., according to wexler) and remember that in a fall this would be 1200 lbs. on the piton and carabiner. Present day carabiners must have closed gates or they lose nearly ½ their strength. Under no conditions must there be a chance of the gate's flying open in a fall.

In closing the author wishes to thank Mr. Earl Whipple of the Harvard Mountaineers Club, who donated the carabiners for the test; and Prof. McClintock, who made available the testing facilities, for their kind cooperation.

Systems Development and The Ramo-Wooldridge Corporation

The Ramo-Wooldridge Corporation (except for the specialized activities of our subsidiary, Pacific Semiconductors, Incorporated) is engaged primarily in developing—and will soon start to manufacture—systems rather than components. For military customers our weapons systems responsibilities are in the fields of guided missiles, fire control, communications, and computers. Our non-military systems activities are in the general area of automation and data-processing.

Emphasis on systems development has consequences that profoundly affect all aspects of an organization. First, it demands an unusual variety of scientific and engineering talent. A single systems development project often requires concurrent solutions of challenging problems in the fields of electronics, aerodynamics, propulsion, random phenomena, structures, and analytic mechanics. In addition, the purely technical aspects of a systems problem are often associated with equally important non-technical problems of operational, tactical, or human relations character.

Therefore, competent systems development requires that a company contain an unusually large proportion of mature, experienced scientists and engineers who have a wide range of technical understanding and an unusual breadth of judgment. Further, all aspects of company operations must be designed so as to maximize the effectiveness of these key men, not only in the conduct of development work but in the choice of projects as well.

At Ramo-Wooldridge we are engaged in building such a company. Today our staff of professional scientists and engineers comprises 40% of the entire organization. Of these men, 40% possess Ph.D. degrees and another 30% possess M.S. degrees. The average experience of this group, past the B.S. degree, is more than eleven years.

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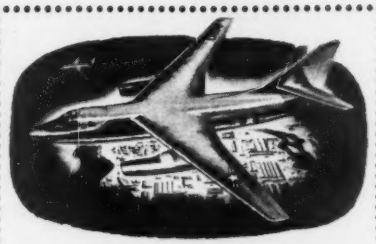

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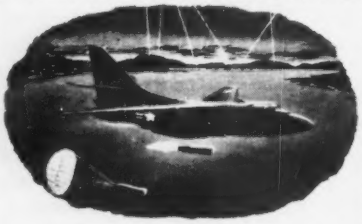

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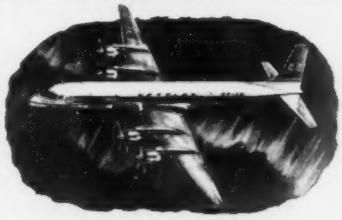

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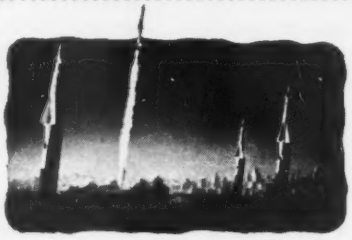

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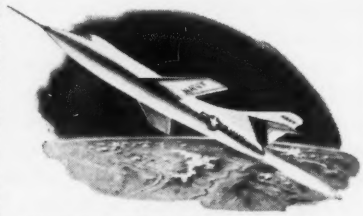

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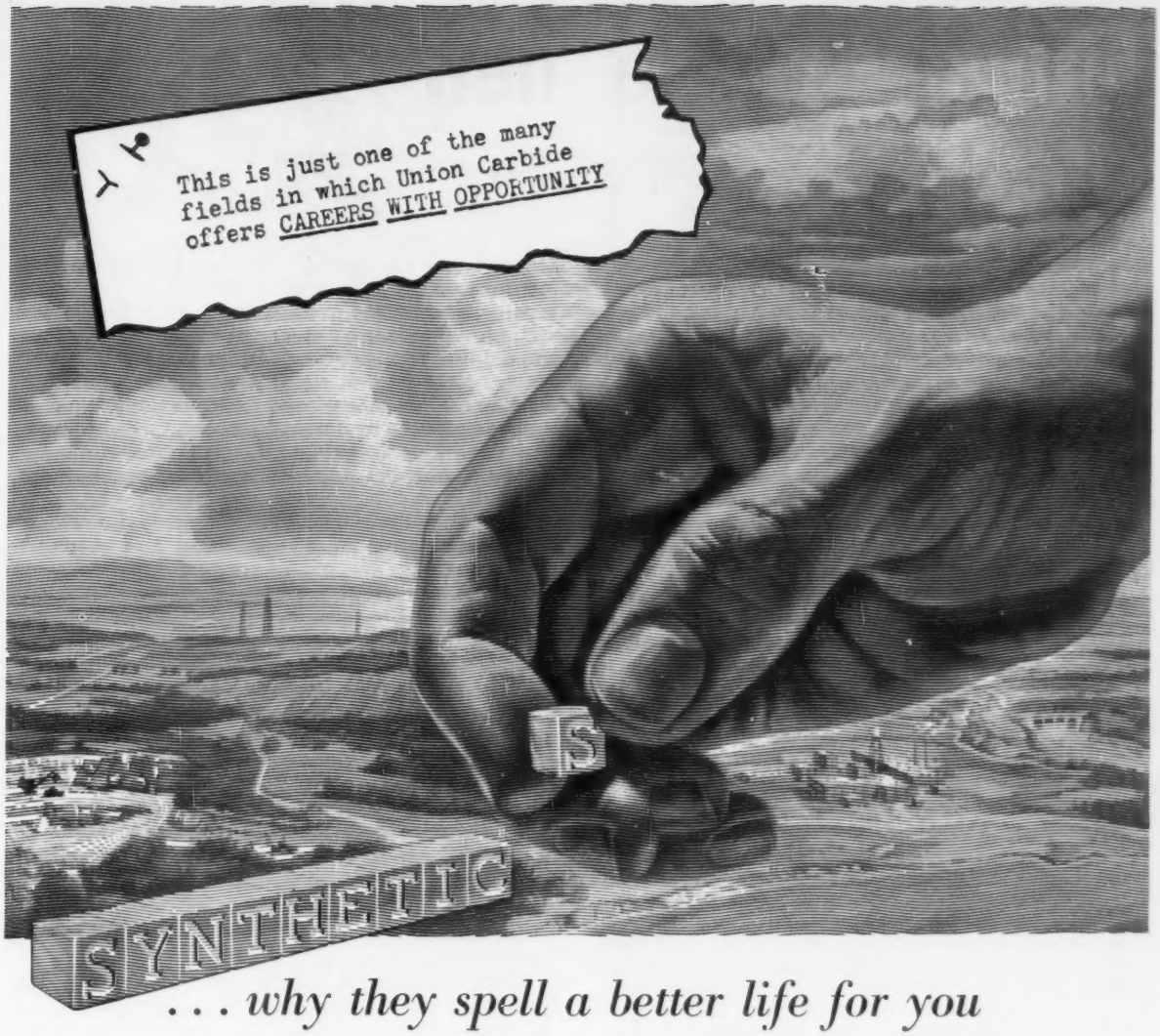

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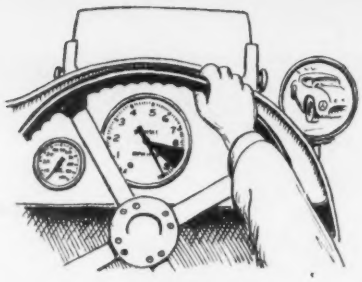


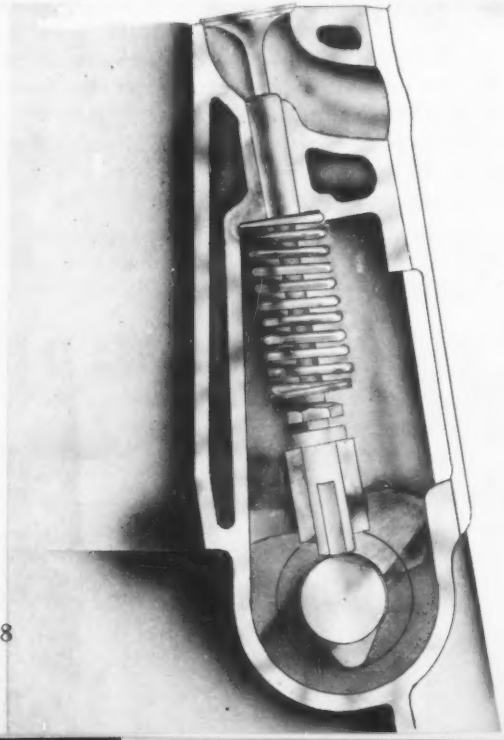
by Carl Estes '57

Editor's Note: Since Karl Ludvigsen left us last year we have been without our "Turning Over a New Wheel" series. Many people have requested that we continue this popular series and so with this issue we reinstate the column. We feel confident that our new author, our present Advertising Manager, will carry on the work.

Since this column is for sports car enthusiasts, I thought a short sketch of the most difficult part of driving, namely shifting, might be in order. Nowadays, many people claim that double-clutching is not necessary and that those who adhere to the practice are only "showing off." Even if this is true, no one can deny that it is easier on the gearbox, even if a synchromesh system is used. There is also a certain sense of accomplishment in a perfectly executed change without any forcing of the lever.

The reason for double-clutching is to get the engine revving at a speed equivalent to that of the gear wheel that is to be selected, so that when the teeth mesh together there is no grinding; but just an increase in the note of the engine.

There are several variations of double-clutching, but the most popular, which can be practiced while the car is stationary, is as follows: assuming that a change down is required, such as going up a hill, release the accelerator slightly and disengage the clutch while at the same time shift the gear lever into neutral; while the gearbox is in neutral, gun the engine and at the same time engage the clutch; release the accelerator, disengage the clutch and at the same time shift down into the desired gear. This last step is the most difficult and must be carried out very quickly because the engine r.p.m.'s must not be allowed to fall below those required by the desired gear. On the second step only practice will teach you how much to gun the engine. If it is given too much gas, you must wait for the engine r.p.m.'s to fall off to the desired ones. Practice is essential to make this a neat and easy series of actions, which after continued practice, a gearchange, using double-clutching, can be made more rapidly than by the conventional method.



With the new Grand Prix season under way, a brief description of a feature of the Mercedes which may be the winning key for the German cars is given below.

The rumor that the new Mercedes, particularly the W-196, will be using a desmodramic valve gear system seems to have become fact. This substantiated by the fact that the Mercedes tachometer reads up to 12,000 r.p.m. in the G.P. cars and circumstantial evidence confirms tachometer readings in these victorious race cars of well over 10,000 r.p.m. Obviously, there is something new under the hood of Dr. Uhlenhaut's machines.

At the high r.p.m.'s required by racing cars, a great deal of trouble is caused by the failure of the valve followers to track the contour of the cam. For the ordinary car, such as any American passenger car, heavy springs which force the follower against the face of the cam, as in figure 1, are suitable.

Unfortunately all coil springs have the inherent disadvantage of being subject to surges, or periods of vibration, at certain predeterminable amplitudes. This causes eratic valve action and in some cases produces what is known as "valve float", i.e.: valves remain open when they should be closed. This surging can also lead to fracture of the spring if it reaches excessive proportions. This can be a very unhealthy situation where clearances between pistons and valves are at a premium. Much stiffer springs became the rule in high speed engines and then designers turned to multiple concentric springs, the natural period of which was selected in such a manner as to overlap each other and thus prevent errors in valve timing and stop bounce.

It is essential that the valves follow the contours of the cam at all times via the interposed followers, fingers, cups, or rockers, in order to achieve maximum volumetric efficiency. Thus it is necessary to use very stiff springs in high r.p.m. engines to keep the parts in contact. Unfortunately, the heavier the springs, the more load on the valve gear, the more power lost, and the greater the loss due to friction.

Therefore it is not surprising that designers began casting around for new ways to force the follower against the cam face. Probably the most classical solution was one evolved by the brilliant

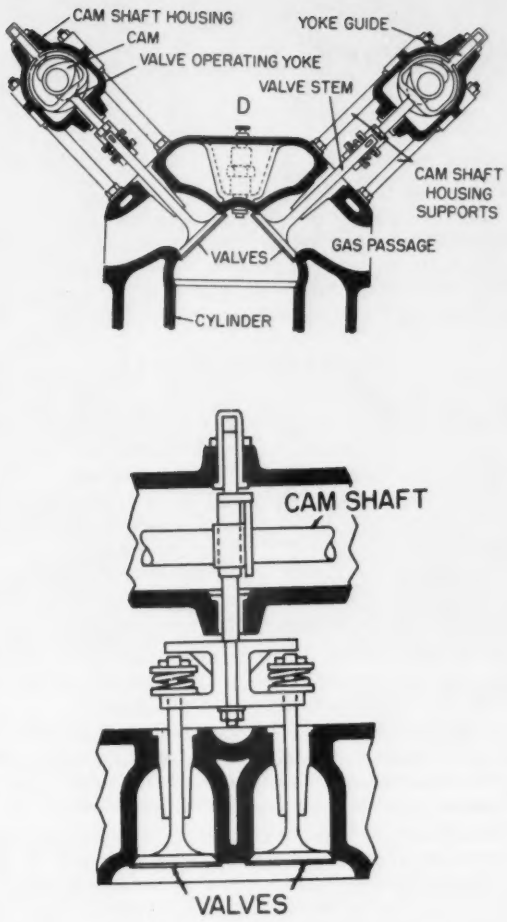


Figure 2.—The 1914 Delage head designed by Herri. Cams rotated inside cam follower yokes with the "conventional-type" opening cam acting on lower part of yoke to open valve and long dwell closing cam acting on upper part of yoke. Yoke cam follower had slight over-travel taken up by stiff short springs fastened to valve stems.

Swiss engineer Henri. His valve system is shown in figure 2. This was the layout designed for the 1914 Delage racing car driven by the great Duray. Here Henri incorporated the desmodromic, or positive action valve system. As can be seen from the drawing, the cams rotated inside the cam follower yoke. The usual type lobe acted on the lower portion of the yoke, opening the valve. The long dwell, closing type lobe, exactly opposite in profile to the opening lobe, acted upon the upper portion of the yoke and held the two valves closed during the compression and power cycle. The sectional drawing, figure 3, shows the method used to give some tappet clearance to allow for heat expansion and still make sure the valves were held tightly closed. The yoke follower had a slight overtravel which was taken up by short, very stiff springs that were fastened to the valve stems in the usual manner.

Unfortunately, no details have been released on the Mercedes system, but it can be assumed that the valve stem is integral with a hollow follower through which the camshaft passes, thus dictating the entire movement of the valve.

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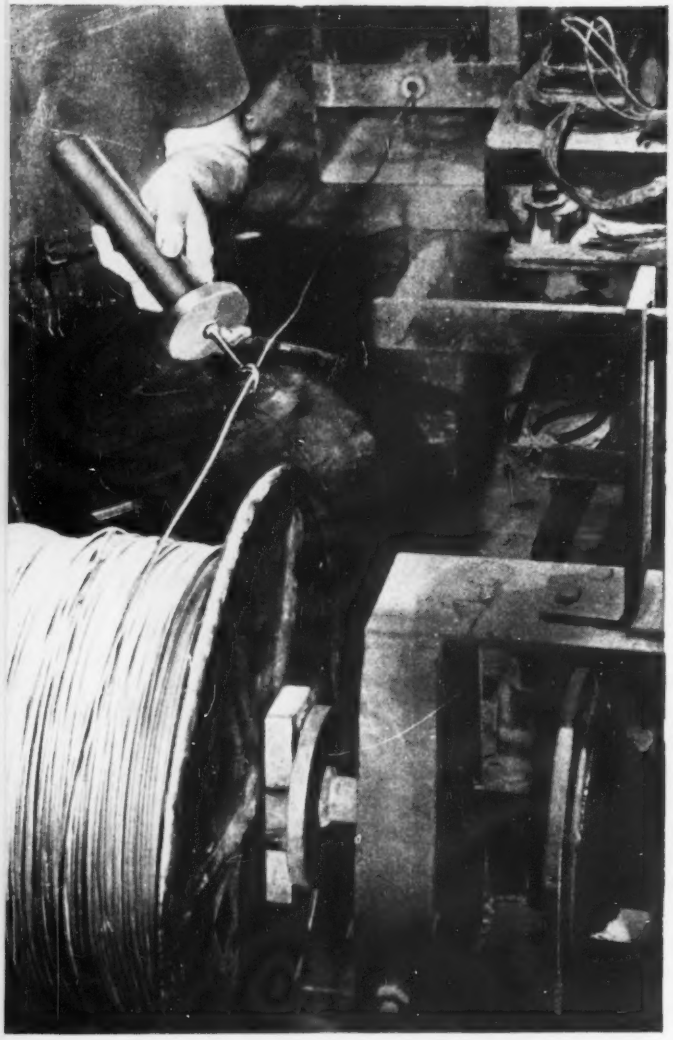

CABLE TESTING (Part I)

It has been indicated in a previous section of this series entitled "Cable Specifications" that practically every element of insulated electrical wires and cables may be covered by some specification requirements. Numerous tests are, therefore, necessary to determine the suitability of such cables for the application for which they are designed. These tests may be conducted on (a) the cable elements during manufacture, known as preliminary tests, (b) the completed cables at the factory, final tests, and (c) after installation. Some of the preliminary and final tests at the cable factory such as conductor resistance, high voltage, insulation resistance and corona level are, generally, non-destructive tests and may be conducted on each entire length of cable manufactured. Other tests, such as insulation and sheath thickness, physical, aging, moisture, resistance, ozone resistance, capacity and power factor, short-time dielectric strength and cold bending and long-time dielectric strength tests are made on short samples selected from a lot of cable.

The following is a general description of these tests and their significance as applied to insulated electrical wires and cables. Details of the test equipment required and the specification requirements are not discussed since they are covered by industry publications such as those of the American Society for Testing Materials and the Insulated Power Cable Engineers Association.

FACTORY TESTS

Factory tests are performed for the following purposes: (1) to determine whether the materials of which the cable is made have the required quality; (2) to determine whether the manufacturing processes such as wire drawing, annealing, compound mixing, insulation extrusion and vulcanization have been performed properly; (3) to detect partial or incipient faults that may have accidentally failed to be detected in the tests indicated in (2); and (4) to determine whether the cable meets the customer's specifications.

Tests on Entire Lengths

CONDUCTOR RESISTANCE. Test is made to insure that the conductor has the required average cross-sectional area and, hence, that its resistance does not exceed the allowed maximum.

SPARK TESTING. The entire length of insulated conductor is subjected momentarily to a high potential to detect and permit the repair of imperfections in the insulation that might cause failure on subsequent voltage and insulation resistance tests.

HIGH VOLTAGE TEST. This test is conducted on each entire length of insulated cable to detect potential faults or weak spots in the insulation and to insure that the insulation will withstand the minimum voltage required by the specification for its rated voltage. The magnitude of the test voltage is determined by the type and thickness of the insulation as shown in the following table for 600 volt cables. The time of application is one minute for code grade insulation, and five minutes for the higher grades.

Insulation Thickness and Test Voltage for Rubber Insulations for 600 Volt Service

Conductor Size, Awg or MCM	Insulation Thickness, 64ths Inch	Code Grade	AC Test Voltages Performance and Heat-Resistant	(KV) Ozone-Resistant
14 to 9	3	1.5	3.0	4.5
8	4	1.5	3.5	6.0
7 to 2	4	2.0	3.5	6.0
1 to 4/0	5	2.5	4.0	7.5
225 to 500	6	3.0	5.0	8.5
525 to 1000	7	3.5	6.0	10.0
Over 1000	8	3.5	7.0	11.5

Cables designed for operation at voltages above 5001 are required to withstand a d-c test voltage in addition to the a-c voltage. This d-c voltage is three times the a-c voltage for ozone-resistant insulations and it is usually applied for 15 minutes.

The high voltage test is made by applying the required voltage between the conductor and water in which the cable has been immersed for at least six hours. When metallic coverings are present, the voltage is applied between the conductor and such coverings. Any failures are repaired and the cable again subjected to the voltage.

No. 9 in a series

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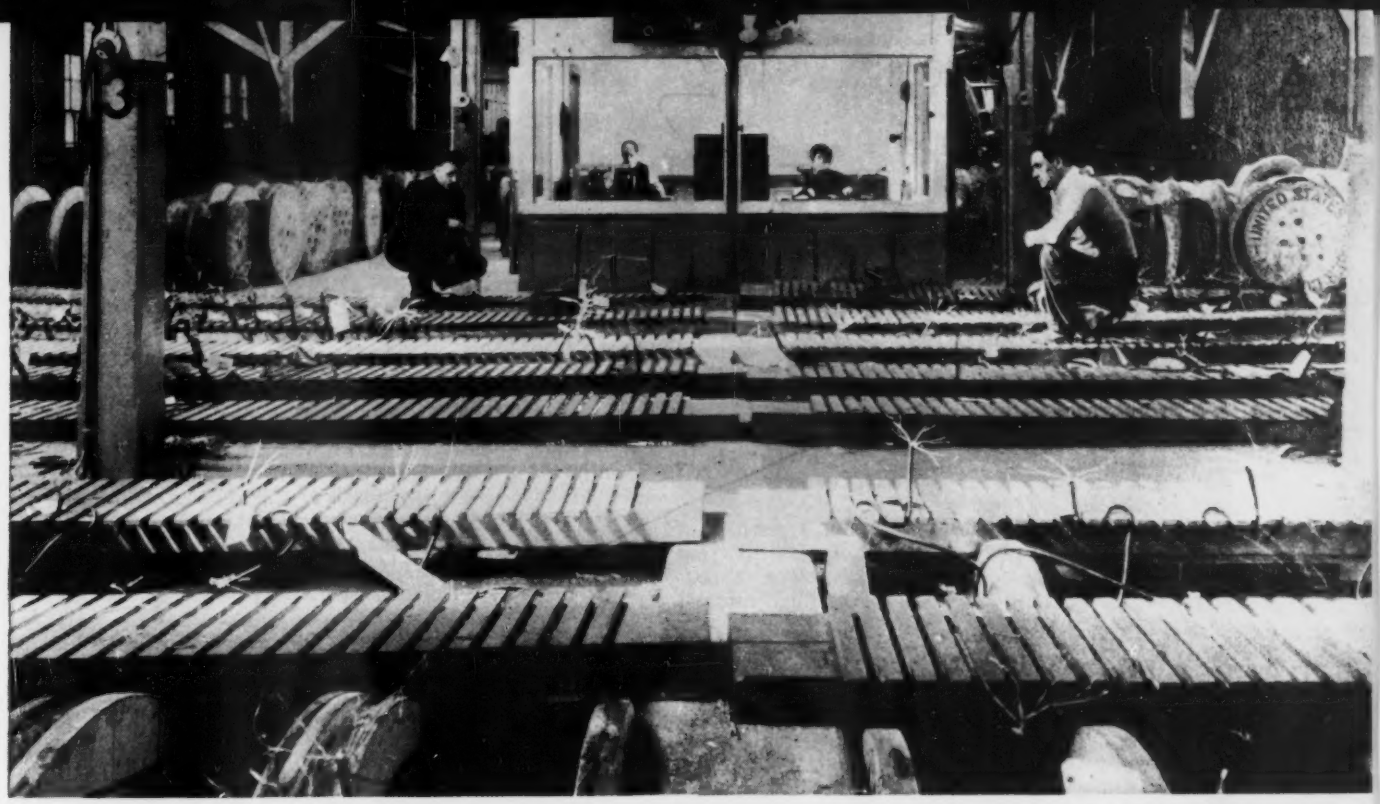

INSULATION RESISTANCE. The insulation resistance test consists of applying a direct voltage of from 125 to 500 volts, usually from a battery, between the conductor and water in which the cable is immersed, or other ground, and measuring the current that flows through the insulation after an electrification of one minute. A suitable galvanometer is generally used for this measurement. From this current and the applied voltage, the resistance of the insulation is calculated and expressed, usually, as megohms (1 million ohms). This test is conducted after the voltage tests and, hence, serves to indicate whether the insulation failed on that test. Insulation resistance also serves to indicate uniformity in processing, particularly insulation compounding, since a well-processed compound should give reasonably uniform insulation resistance. Most wire and cable specifications contain minimum requirements for insulation resistance so that this test determines whether or not the specification is complied with.

The resistance of insulations is inversely proportional to the temperature, that is, it is lower at high temperatures. It is, therefore, necessary to note the temperature at which the insulation resistance is measured and to apply a correction factor to reduce the resistance to a standard temperature. The insulation resistance varies with the type of insulation, its thickness and the size and length of the conductor. The following formula gives the relation between these factors.

$$\text{Insulation Resistance, Megohms} - 1000 \text{ feet} = K \log_{10} \frac{D}{d}$$

Where, D = Diameter over the insulation, inches
d = Diameter over the conductor, inches
K = A Constant for the insulation used

CORONA OR IONIZATION LEVEL. This test determines the voltage at which ionization or corona develops in a length of cable and is usually made only on cable for operation above 4000 volts. It is made by applying a gradually increasing a-c voltage between the insulated conductor and water or other ground with an oscilloscope in the circuit. Any air entrapped at the surfaces of the insulation or within the insulation will ionize when a sufficiently high voltage is applied resulting in the formation of more active oxygen or ozone. These materials are detrimental to most organic insulations particularly when such insulations are under physical tension, and thus may cause premature failure of the insulation. This ionization is indicated by the appearance of high-frequency oscillations on the charging current trace of the oscilloscope. In actual practice, the voltage at which ionization is extinguished rather than initiated is determined. For long cable life, this extinction voltage should be at least 110 per cent of the rated voltage to ground.

Wire and cable specifications generally require that these tests be made on the completed product. High voltage and insulation resistance tests are usually also made immediately after the insulation has been applied and vulcanized. This is general insurance that cables passing the test will meet the requirements when completed.

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briefing the news

Brain Tumors

Radiation Produces Useful Changes

Radiation is used to produce useful changes in human beings, animals, plants, chemicals and metals at Brookhaven National Laboratory, according to the Laboratory's 1953-4 report, just published. Dozens of research teams representing Brookhaven or collaborating organizations conduct radiation research, some of which already are improving man's control over living and inert matter.

In 1951 the Laboratory began using neutrons to bombard brain tumor in human beings. In this approach, a chemical containing boron is injected into the blood stream, and is absorbed in larger quantities in brain tumor than in normal brain tissue. When neutrons enter, boron atoms capture them, then disintegrate. Each disintegration is believed capable of destroying a single cell of the tumor.

150 Man-and-Woman Team in Brain Tumor Treatment

Many research teams work together in the neutron capture therapy experiment, involving perhaps 150 persons, part-time. Large colonies of mice are given brain tumor. Studies by research workers in a physiology group evaluate the various effects of neutron exposure on the tumor, and on other parts of the animals' biological systems. A pharmacologist and his assistants try various boron compounds on the mice, to determine the maximum amount of boron which the brain can take up without toxic boron effects on the organism.

A medical physics group evaluates methods for measuring the amounts of different kinds of radiation which penetrate various types of tissue. One experimental approach is exposure of instruments in a tank of liquid chemicals. The chemicals are carefully compounded to include the proper proportions of the elements most plentiful in the human body. These elements are exposed to neutrons in a "cave" of lead bricks alongside the reactor.

Another approach, a joint effort with the Brookhaven electronics division, is to design scintillation counters which will detect heavy alpha particles produced when boron splits the brain. The problem is to get around interference from neutrons, gamma rays and other radiation which is not specifically effective in destroying tumor cells. The Radiological Research Laboratory of Columbia University's College of Physicians and Surgeons is collaborating in the attack on such problems.

All 14 patients so far have been referred by Massachusetts General Hospital, Boston, where early boron studies were made. Staff members of this hospital collaborate with the Brookhaven pathology group in examining brain tumor tissues before and after neutron therapy. They also collaborate with members of the Brookhaven hospital group, in care of the patients being treated. "Behind the scenes" personnel include nurses, laboratory assistants, technicians who fabricate and install equipment at the reactor, and men who operate the reactor.

A technical development of the past year was design and construction of a two-ton steel and lead "shutter", with control equipment. Because the shutter shields the patient while the reactor is running at full power, the attending physicians can now work at the patient's side right up until the radiation treatment actually starts. The new arrangement provides neutrons at 10 times the original rate, a factor which greatly increases the destruction of the tumor. This fact suggests the desirability of still greater concentration in possible use of future reactors for brain tumor therapy.

Neutrons Used to Alter Plant Seeds

Brookhaven's newest large-scale collaboration is the use of another facility at the top of the reactor for exposing plant seeds to neutrons. Two years ago a Laboratory group exposed oats seeds to neutrons; after planting, the seeds exhibited resistance to a powerful rust disease. This was just one type of mutation, or change, resulting from exposure, and Brookhaven workers did other studies with barley and corn. Findings have to do with type of damage to chromosomes and other units of heredity, the influence which water content has on sensitivity, and differing radiation effects produced by neutrons, gamma rays and X-rays. For example, neutrons seem to produce many more mutations than do other forms of radiation.

One of the most interesting findings in neutron irradiation of barley and oats is that dominant mutations are produced. Because it has always been assumed that radiation destroys genes, the basic units of heredity, only recessive mutations have been expected in irradiation. A reinterpretation of radiation-induced mutations is now indicated.

Between mid-1953 and mid-1954, 39 different educational and agricultural organizations sent in plant seeds for neutron irradiation. They hope in this way to produce new varieties of plants. The organizations range all the way from the Rockefeller Institute for Medical Research to the Alaskan Agricultural Experiment station, and from Louisiana State University to the Canadian Government Experiment farm, Swift Current, Saskatchewan.

The Texas Experiment station will attempt to produce rice with a short rice stalk which will resist wind damage, the University of Nebraska to produce soy beans which mature early, the University of California to produce flax resistant to a wilt disease, and so on.

For the second year, agriculture experiment stations have placed plants in the 9-acre gamma field, around an 1800 curie source of radioactive cobalt. Most of the northeastern states are represented, and plants include many varieties of fruits, shrubs and berries. The field is an attempt to produce mutations which will prove economically important to farmers.

One type of change in the life process of potatoes is of economic interest. A Brookhaven group found that gamma rays can retard sprouting and rotting in potatoes, thus improving their storage life. Additional studies are now being carried out jointly by the Laboratory and the L. I. Vegetable Research Farm in Riverhead, N. Y.

Even tiny amounts of radiation can be used as a tool, in experiments with animals as well as plants. For example, in a joint Columbia University-Brookhaven experiment, atoms of radioactive iodine are injected into a mouse and are carried by the bloodstream to the thyroid gland, which they destroy. As a result, the pituitary gland grows a tumor, for reasons not altogether understood.

The theory being tested is this: while the absence of the thyroid causes the pituitary to secrete abnormally large amounts of the hormone which stimulates the thyroid, demand increases for a secondary hormone the pituitary also produces. This over-activity presumbaly causes the pituitary to increase in size, and eventually become tumorous.)

Tracers Chart Role of Basic Substances

Several research teams in the Brookhaven medical department use radioisotopes to "go in and seek out" information about the distribution of a specific substance and its fate in the body. An example is the attempt to find the defect caused in living processes (metabolism) by hypertension, or high blood pressure. Low sodium diet reduces blood pressure in about one-third of persons suffering the disease, for reasons not understood.

A group of Brookhaven physiologists injects in hypertensives sodium which includes the radioactive species, sodium 24. Blood samples are taken at intervals; measurements of the radioactivity, plus calculations, produce an estimate of the total amount of sodium in the body. The procedure is repeated with potassium 42 and other radioisotopes. As the patient's blood pressure lowers, the relative quantities of these elements are compared. Thus it is possible to eliminate various combinations as possible factors in the metabolic defect.

This group is also testing a hypothesis that hypertension is basically a disease of the smooth muscles of the arteries. The effects of temperature, oxygen content and other variables on concentration of sodium and potassium are being studied. The method is to count radioactive tracers of the latter elements present in slices of smooth muscle from pigeon gizzards. This muscle is abundant in pigeons, and is similar to human smooth muscle.

One of the most effective enemies of cancer is radioactive iodine 131. When administered to a patient, this radioisotope is attracted to the thyroid, where its radioactive rays bombard cancerous tissue. A Brookhaven group used iodine 131 for another purpose: to learn more about how thyroid hormone (in which thyroid cancer patients are deficient) helps break various materials down for use in the body. They used iodine 131 to label serum albumin, that component of the blood which carries hormones and other materials essential to life processes.

Samples of the blood of patients suffering from cancer of the thyroid were counted at two different time intervals for presence of radioactive iodine atoms. The counts were so similar that they indicated the serum albumin had turned over its products in the rotation of life processes about 30 percent more slowly than normal. Thyroid hormone was then injected, and turnover increased. This fact suggested that normally, the hormone plays an active role in the metabolism (life function) of serum albumin.

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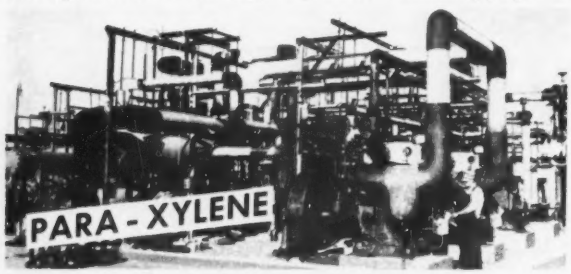

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Animal Fat and Plant Sugar

A group of biochemists used radioactive carbon 14 to label fat, and thus study its digestion in the intestinal tract and in the wall of the intestine of a rat. The object was to determine how much splitting of fat takes place during its absorption and how rapidly this splitting occurs. By counting samples containing carbon 14 it was found that a small amount of fat was rapidly split in the intestinal tract, while of the remaining fat, half was split in the intestinal wall and half was absorbed unsplit.

A team of physiologists feeds carbon 14 labelled sugar to rats whose adrenal or pituitary glands have been removed. Blood sugar levels and sugar utilization rates are Geiger-counted; diminished quantities of carbon 14, proportional to sugar consumed, reflect a decline from normal levels and rates. These declines are a measure of the role of the hormone normally supplied by the gland.

Carbon 14 is the key with which another Brookhaven team hopes to unlock some of the secrets of photosynthesis, the process by which plants manufacture food from carbon dioxide and water, with the aid of sunlight. Man has found no way to "stop the clock" and examine, one at a time, the hundreds of chemical reactions which take place in a split second as carbon dioxide and water become intermediate sugars, and eventually complex carbohydrates. However, a few of the intermediates have indeed been determined through carbon 14 labelling.

Brookhaven research now centers on the slower reverse process, in which the plant breaks down sugars for its own consuption. Many intermediate stages have been worked out, and these presumably apply also to the forward reaction.

Neutrons as Probes

A team of Brookhaven chemists, another of physicists, and groups from outside organizations, use neutrons from the reactor to "scan" metals and other solids and reveal relative positions of various atoms. Since neutrons, like the atoms themselves, behave as small magnets, the way a magnetic crystal scatters them gives information on orientation of magnetic atoms in the metal.

A group from Pennsylvania State University is investigating the arrangement of hydrogen atoms in rochelle salt and other electrically polarized solids. A joint project of Brookhaven and a group at the Norwegian-Dutch reactor, Kjeller, Norway, has been studying the changes in the alignment of atomic spins in an iron oxide with temperature change. A group from the General Electric Company uses the reactor in studying magnetic structures which include a bismuth-manganese alloy.

NIKOLA TESLA, THE MAN WHO HARNESSED NIAGARA

Water, water, everywhere — and no power. That was Niagara Falls when Nikola Tesla began work on its power system in 1888. Now Niagara is one of the world's largest electric power plants.

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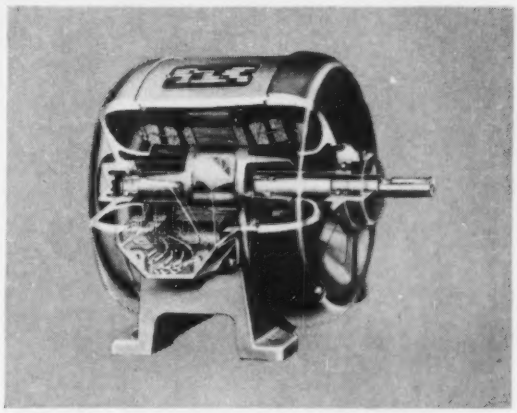

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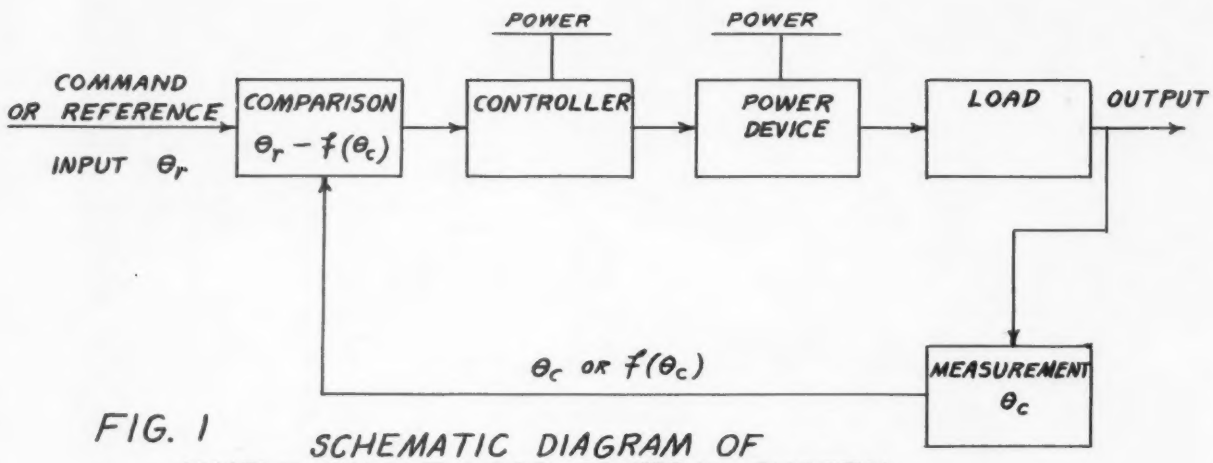


FIG. 1 SCHEMATIC DIAGRAM OF SIMPLE SINGLE-LOOP CONTROL SYSTEM

Finding a good definition is as hard as defining sin. It has been said, "A control system is an arrangement of elements (amplifiers, converters, people, etc.) interconnected in such a way that the operation of each, other than the input element, depends on the operation of one or more other elements, and the purpose of which is to control some process or machine."

For a system to need controlling, it is apparent that it must be variable in some way. There are three ways in which this controlled variable may vary: (1) a change in input signal; (2) a disturbance of some sort; (3) the nature of the process itself. An example of (1) is partially closing a valve to slow down an engine. (2) could be expansion in a valve, causing something to close down slightly. This is disturbance. An example of (3) is raising the temperature of H_2O at a constant rate from —10°C to +10°C; at 0° an additional 80 calories per gram must be added.

Control systems serve two great purposes: to cause a system to adjust to changing conditions, or to cause a system to remain constant despite changing conditions.

There are at present three applications of control systems; one is to regulate on a small scale—engine speed or room temperature; a second is process control, such as has been done in the petroleum industry; and the third is remote-control applications. In regulation and process control it is a case of dealing with disturbances rather than input fluctuations. In remote control it is a case of input fluctuations rather than disturbances, (which are handled by control systems in the remote object, and so come under the first category). There is also a difference in response time, the time the system takes to correct an error. In the first and third applications it is usually a few seconds. In process control response time is usually in minutes due to the nature of the process or the complexity and larger scale of the system.

A control system that is not self-correcting is called an open-loop system; an example is a switch and furnace that will supply heat when the room is cold, but will not turn itself off when the heat is no longer needed. A control system that is self-correcting is a closed-loop system, such as a furnace and thermostat.

A control system that operates without the guidance of man is an automatic one; it may be either open- or closed-loop.

A closed-loop system is based on the idea of feedback, or taking a measurement of the output and comparing with the desired signal, the input. When the difference, or error, is found, the system adjusts a control to correct the output. In figure 1 such a control system is diagrammed. The input is the command or reference, the desired result. This signal is applied to the control, which amplifies it and adjusts the power device, which operates on the load, the output. A measurement of the output is taken; if inaccuracies or disturbances have caused a shift in output, the measurement will differ from input; the two values are compared and a correction sent to the control element.

There are five methods of correction, differing in the accuracy of output to input and the nature

of the system.

I. Discontinuous Correction
   a. On-off
   b. Two values and off
   c. Multi-valued
II. Continuous Correction
   a. Linear
   b. Non-linear

Figure 2 explains these methods of correction. Discontinuous correction is a correction that is made only after the error has exceeded a certain value. The correction may be proportionately larger with the error. On-off correction will correct when output is below the input value by turning on the power element; if the output is above the input, the device will turn off and allow the excess energy to dissipate. A differential or "spread" is put in this simple control system because otherwise the device would correct for a very small error and in so doing would constantly be turning on and off; usually great accuracy is not demanded of this simple system.

The two-values and off system either makes corrections for errors in either direction or a greater correction for a greater error in one. The multi-valued system is a refinement of this.

Continuous correction is a correction made no matter how small the error. Linear correction assumes that correction proportional to the error will eliminate it; non-linear correction allows for the nature of the system.

Closed-loop systems operate on the theory of feedback. Feedback is a comparison of two values; the desired state and the output. In a closed loop, the end controls the means. The correction is usually equal to the error; but at least two factors can make the two unequal. One is the time lapse between noting the error and making the correction. During this lapse, the error grows greater. The second factor is the propensity to carry past the correction—due to inertia or similar effects. This creates an error in the opposite direction, necessitating another correction, etc. This is oscillation. Where feedback is equal and 180° to error a regular fluctuation follows; where it is greater and 180° to error, the error is amplified indefinitely, until it reaches the limit of the power that is in the system. A third case is one where the feedback is less than the error. This is caused by friction, energy loss, etc.

One way of minimizing oscillation is multiple-loop systems where the error is sent to several points which each make a fraction of the correction. Open-link systems do not have this instability because they have no feedback.

Similar oscillations are found in other cause-and-effect phenomena, such as weather, economics, etc. It was the work of Fourier in wave mechanics that made much of our development in control systems possible. Fourier analysis is part of the mathematical basis of feedback.

Application of control systems and their development has been carried out by the military and industry primarily. We now have automatic factories, weapons such as the Skysweep radar-

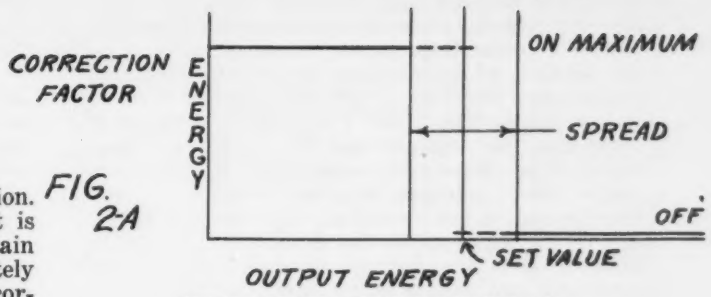


FIG. 2-A

OFF – ON CORRECTION

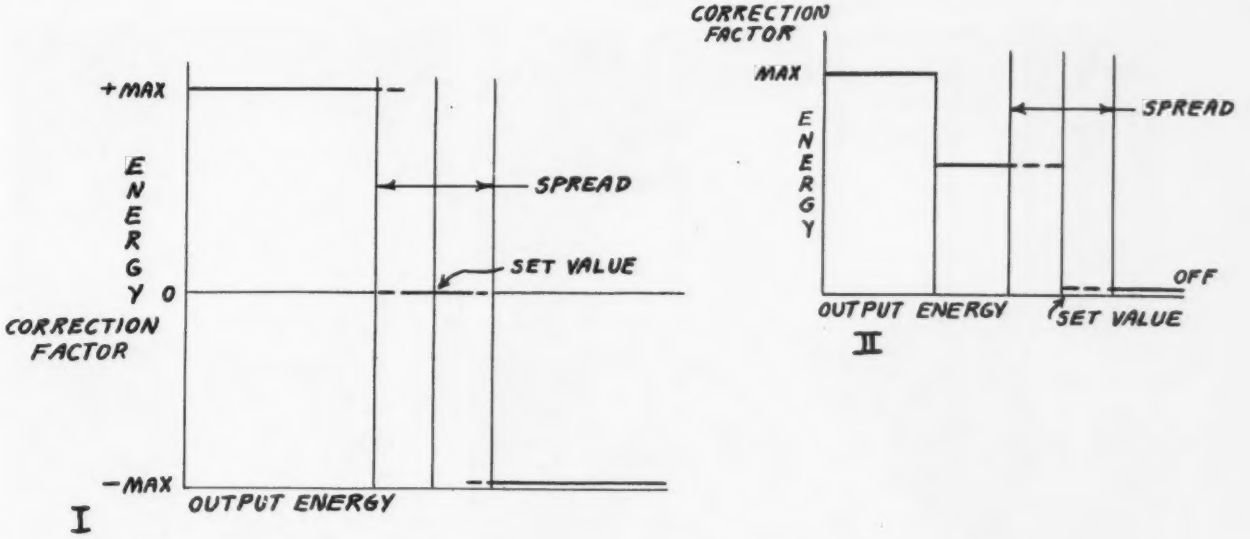


FIG. 2-B

2-VALUE + OFF CORRECTION

controlled anti-aircraft gun and Nike, the anti-aircraft rocket. In such complex systems the problem of coordinating several systems arises; also the problem of determining the proper correction complicates itself. It is here that the use of computers comes into view. There are two types of computer, the analogue and the digital. The analogue type represents quantities as distances (slide rule), voltages, angular velocity, etc. and handles only a few variables. Their accuracy usually is not as great as the digital, which can be built to give any desired accuracy. The digital computer can handle many numbers, variable or constant. They do this by counting in some fashion—neon bulbs, relays, etc. are assigned to the digits of the numbers. Usually this is done, for reasons of economy, in the binary system. Therefore analogue computers are used on simple control loops, while the digital computers are used on more complex loops or to coordinate several systems.

The usual plan is for each step in the process to have its separate control system which is connected to the computer. At the end of the process there is a method of product analysis which acts as a control for the entire process through the computer. An example of this type of control is the petroleum industry. On schematically laid out control boards are the necessary controls to run the entire plant, from cracking units to storage towers.

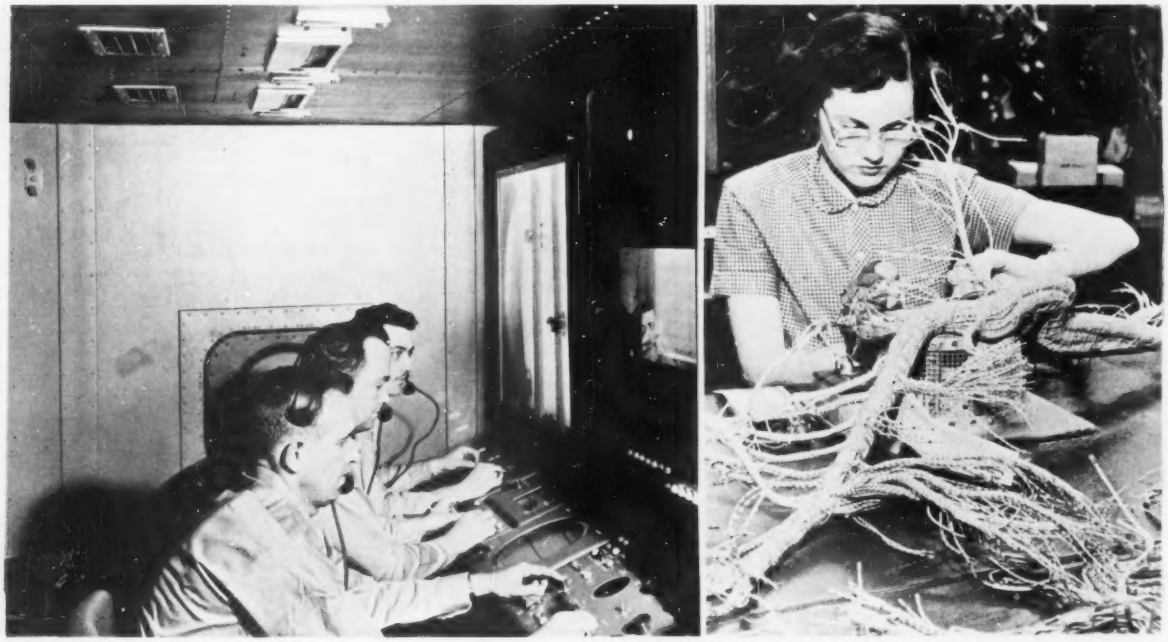
The methods of applying these methods are several. Many control systems are electrical, being comprised of electric motors, generators, amplifiers, and meters. Comparisons are made by use of selsyns, which are devices which measure angular velocity and displacement. In many plants, chemical plants in particular, electrical systems are dangerous and against the law. Therefore pneumatic and hydraulic systems are used. In flow control the usual regulator is a pressure system. The switch itself is a cylinder containing a piston. The desired state is represented as a certain pressure, adjusted by a spring. The output is represented as a pressure on the opposite side of the piston. As the output changes, the piston moves accordingly to correct it. This is a good example of continuous correction. These mechanism controls are called servo-mechanisms.

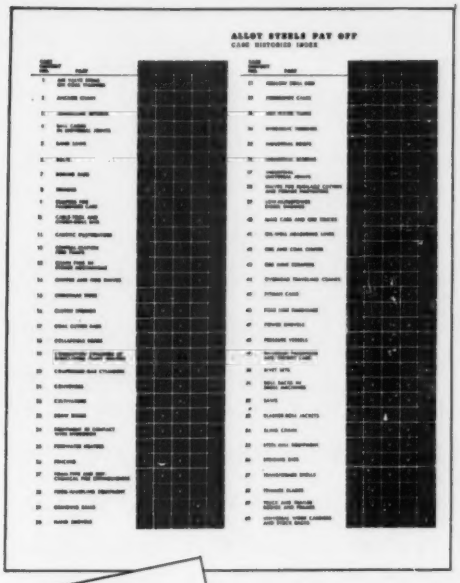
Process control probably offers the widest range of gadgets to test quality and to make the necessary corrections. Almost every possible physical, chemical, and biological property that can be measured has been used in process quality control. Photocells are used to detect flaws in sheet metal. Electrical conductivity determines humidity in textile mills.

Process control demands slightly different methods because of its characteristic of holding energy over a longer period of time than remote and regulation control. It takes longer for a change in process control to take place because systems which lose energy rapidly respond rapidly to a correction, and process systems are usually designed to hold energy for a long time. An example is that of changing the temperature in a water tank. Raising it is fairly simple, but lowering it is difficult because the tank is insulated to hold the heat and be operated at a lower cost.

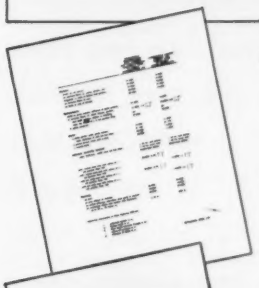
Control systems are replacing man at the switches more and more. There are several reasons for this: in many cases the work is boring and uninteresting; it may be dangerous; greater precision is needed than a man can give; and often it is cheaper to use a machine than to train men for the job. The last is especially true in instances where there is a high turnover rate.

Inside this central control van, military personnel watch radarscopes as the Nike system automatically guides the missile to the target. Shown in the inset is a cabling operation at a Western Electric plant. Many miles of wire and cable are used to link together the maze of electronic components needed in the Nike control system.

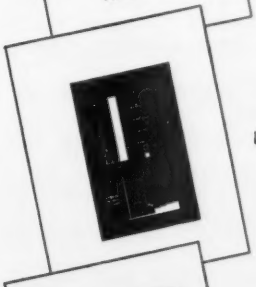




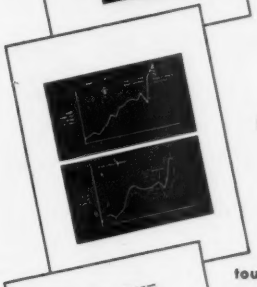
60 fully documented case histories



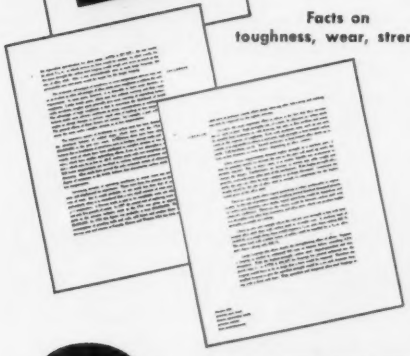
Facts on maximum pay load



Facts on lower operating costs



Facts on lower corrosion rate



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A Campus-to-Career Case History

"This is what I did yesterday"

"I like a job that keeps me jumping," says Bill Jermain, C.E. from Marquette, '52. "And my first management assignment with Wisconsin Telephone Company does just that. I'm Service Foreman at Sheboygan, with nine installers, and that means variety of responsibility. But judge for yourself. Here's a quick run-down of what I did yesterday, on a typical day—

8:10—"Checked day's work schedule. One of my new men was putting in a buried service wire, and I went over the job specs with him to be sure he had things straight.

8:30—"Answered mail while my clerk checked time sheets from previous day.

9:30—"Out to supervise installation of the first aluminum Outdoor Telephone Booth in my exchange. Reviewed the assembly instructions with the installers, then arranged for special tools and bolts to be delivered to the job.

11:30—"Drove across town. Made a 'quality inspection' on a telephone installed last week. Everything checked O.K.

12:00—"Lunch.

1:00—"Picked up film for next day's safety meeting. Watched the film, made notes for discussion.

2:00—"Met with moving company manager to estimate cost of telephone cable lifting for a house moving job. Drove the route he had planned and worked out schedule for construction crews.

3:30—"Returned to aluminum booth installation. Went over wiring specs with the electrician.

4:00—"Stopped at Central Office to pick up next day's orders. Met installers at garage as they checked in and assigned next day's work."

Bill has been in his present job about a year, and is looking forward to new responsibilities as his experience increases . . . as are the many young college men who have chosen telephone careers. If you'd be interested in a similar opportunity with a Bell Telephone Company . . . or with Bell Telephone Laboratories, Western Electric or Sandia Corporation . . . see your Placement Officer for full details.

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Cliff Litherland asks:

Would I have varied assignments at Du Pont–or would I specialize technically?

CLIFFORD LITHERLAND received a B.A. degree from Rice Institute last year, and is now working for a B.S. in Chemical Engineering. He is Business Manager of "*The Rice Engineer*," and Vice-President of the fifth-year class at Rice. By asking questions of prospective employers, Cliff is trying to get information that will help him make the best use of his training in the years ahead.

ARTHUR I. MENDOLIA was graduated from Case Institute in June 1941 and started work with the Du Pont Company that same month. In addition to handling challenging assignments at work, he also enjoys some interesting hobbies. Although he makes no claims personally, he's classed as a minor authority on golf and hi-fi music. Mr. Mendolia is Assistant Director of Research for Du Pont's *Electrochemicals Dept.*

Arthur Mendolia answers:

Well, Cliff, I'd say the answer to that question depends largely on your own preferences. In a company the size of Du Pont there are opportunities for growth along either line.

In my own case, I've followed the route of diversification—and I think you'll find that's the general procedure when a fellow is interested in administrative work.

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You see, variety of assignments means contact with new men and with constantly changing problems. That keeps interest alive. It leads to growth, too, because it provides a broad base of experience for future responsibilities.

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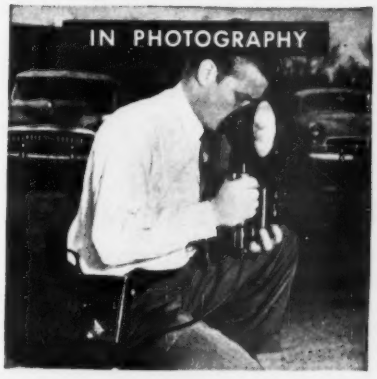

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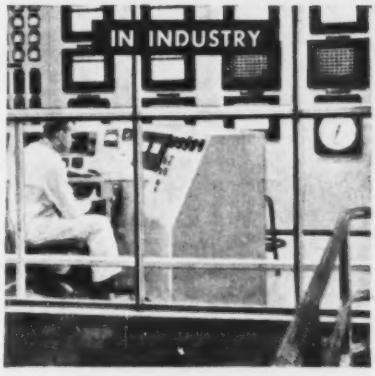

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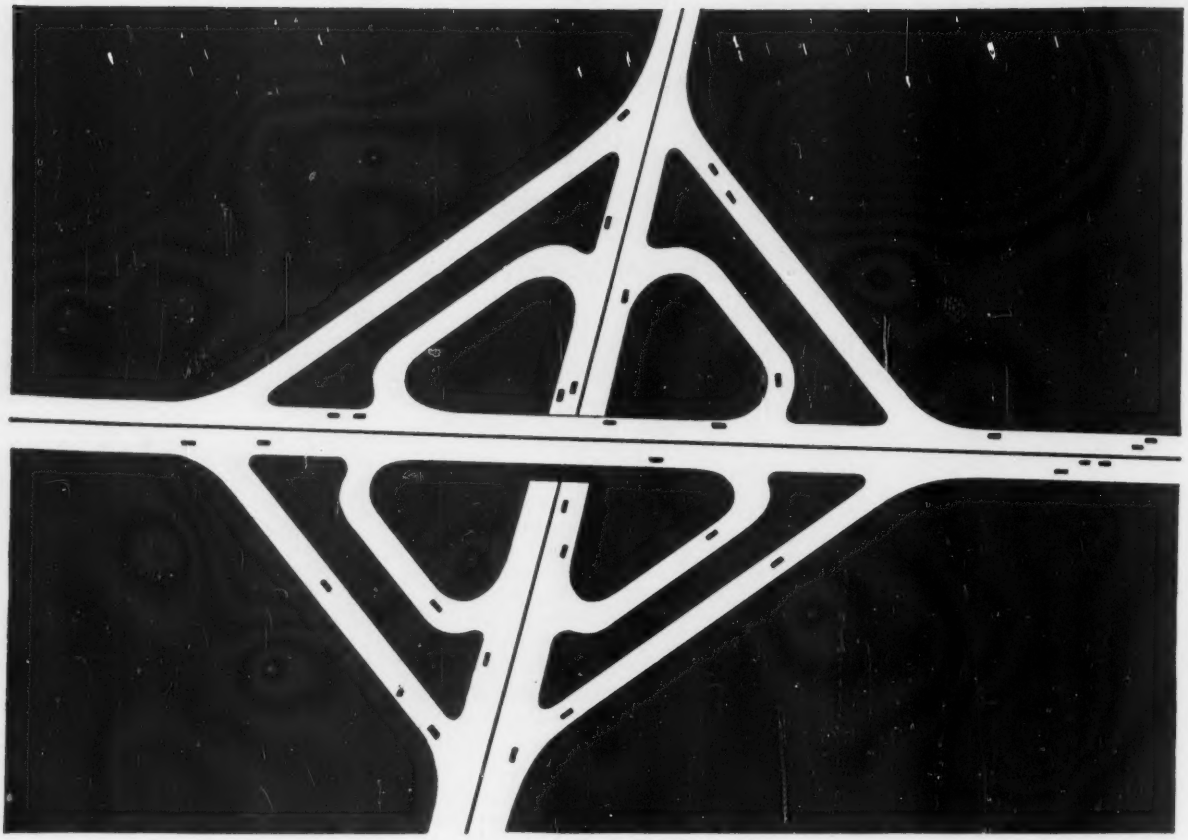

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*ILLUSTRATION: *Sales Engineer and customers discuss turbine rotor construction. Glasses are factory safety measure.*

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